3. PO.DAAC Configuration

3.1 Introduction

3.1.1 PO.DAAC Overview

The Physical Oceanography Distributed Active Archive Center (PO.DAAC) is one of the eight DAACs that are major components of the NASA Earth Observing System Data and Information System (EOSDIS). The PO.DAAC will utilize the EOSDIS Core System (ECS).

The mission of the Physical Oceanography Distributed Active Archive Center is to archive and distribute data relevant to the physical state of the oceans. The goals of PO.DAAC are to serve the needs of the oceanographic and geophysical sciences research communities and to provide data in support of interdisciplinary research. The requirements to support the following activities have driven the design of the PO.DAAC ECS segment:

- acquiring, compiling, processing and distributing data obtained from spaceborne and conventional instruments which measure the physical state of the oceans;
- producing and distributing higher level data products;
- providing an increasing range of data services to the broad research community;
- lessons learned from the PO.DAAC Version 0 activities, which are guiding the planning for the Version 0 to Version 1 transition.

Products available from PO.DAAC are largely satellite derived. Products include:

- sea-surface height,
- surface-wind vector (and sigma naught),
- surface-wind speed,
- surface-wind stress vector,
- integrated water vapor,
- atmospheric liquid water,
- sea-surface temperature,
- sea-ice extent and concentration,
- heat flux, and
- in-situ data as it pertains to satellite data.

This Release B Design Specification establishes the PO.DAAC ECS configuration and capabilities at Release B. These capabilities are selected from two ECS design segments referred to as the Science Data Processing Segment (SDPS) and the Communications and Systems Management Segment (CSMS). Figures 3.1.1-1 and 3.1.1-2 illustrate the SDPS and CSMS subsystems and their components for Release B. This document addresses how the PO.DAAC's Release B version of SDPS will provide the hardware, software, and operations to:

- provide full functionality and performance for SeaWinds and DFA to receive, process, archive and manage scatterometer and ancillary data within the Information Management and Archive Functions;
- receive, archive and manage in situ correlative data;
- provide the Earth science community with access to data held by the ECS and the data products resulting from research using these data;
- support migration of V0 data and to promote exchange of data and research results within the science community and across the multi-agency/multi-national data collection systems and archives; and
- facilitate development, experimental usage, and community acceptance of new and/or improved science software for computing geophysical parameters from remotely sensed data.

Likewise, this document addresses how the PO.DAAC Release B version of CSMS will provide the hardware, software, and operations to:

- interface with the EOSDIS Backbone Network (EBnet) for the ingest of Level 0 data;
- provide full functionality and performance to EBnet links among the Distributed Active Archive Centers (DAACs) to support exchange and archive of mission-related science products, and ancillary data sets required by SDPS;
- support status exchange between various sites and the DAACs for both operational and test efforts;
- to provide full functionality and performance for all System Management functions.

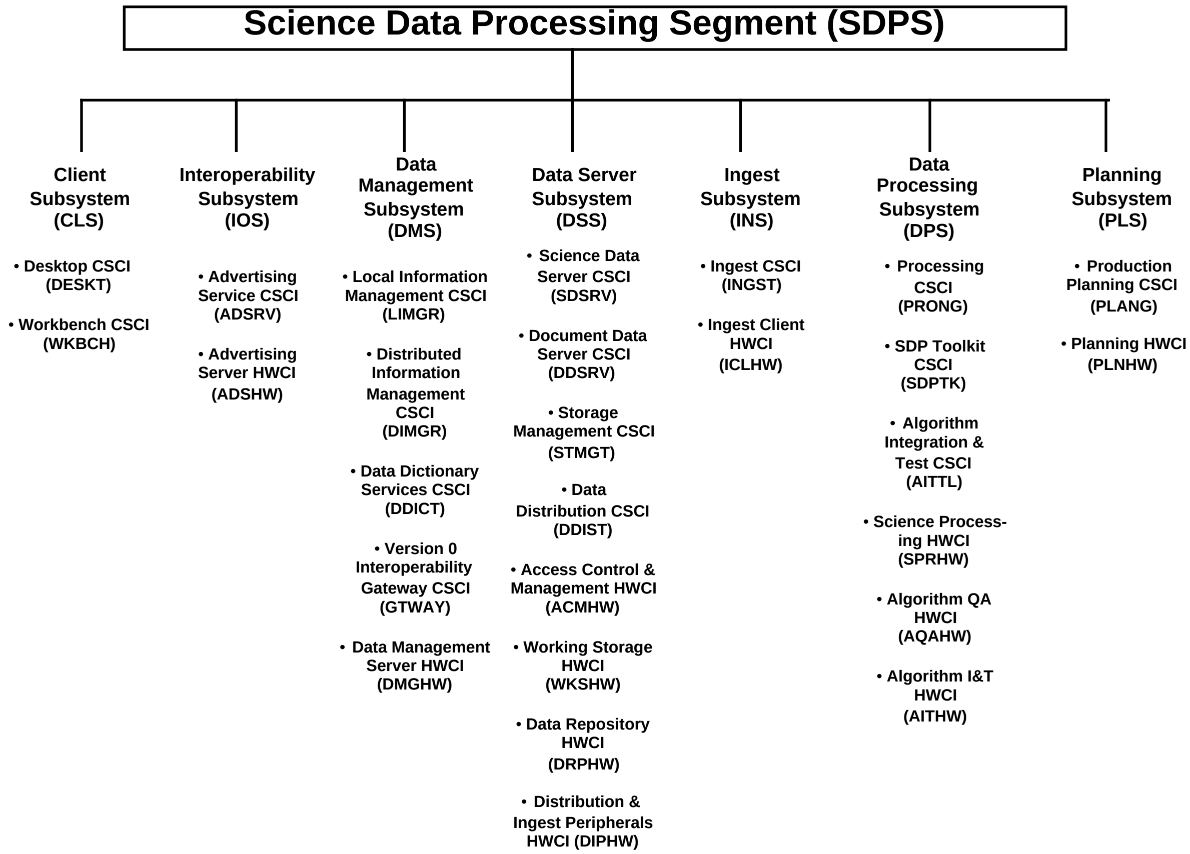

Figure 3.1.1-1. SDPS Subsystems and Configuration Items

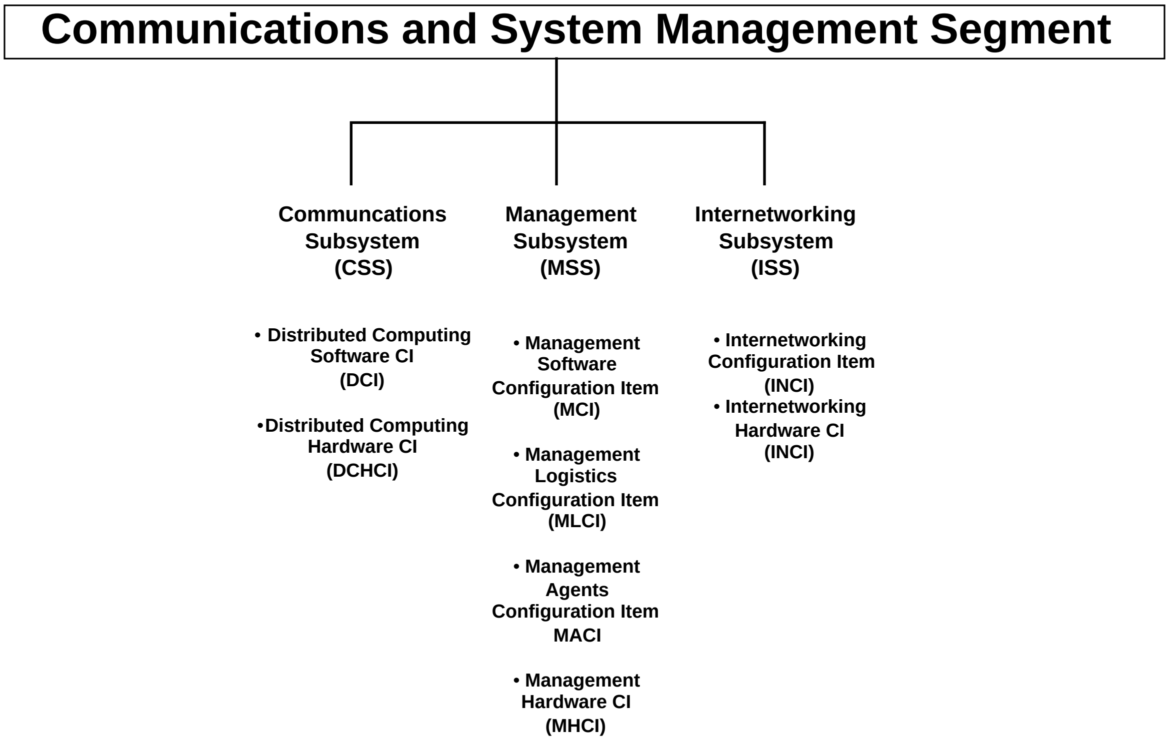

Figure 3.1.1-2. CSMS Subsystems and Configuration Items

3.1.2 DAAC-Specific Mission and Operations Activities

The overall objectives of Release B are to provide ECS components for continued TRMM mission support as well as mission support (which includes where applicable DF & EE Testing, Simulation Readiness Testing and Ground System Testing) for the EOS AM-1, COLOR, ADEOS-II and Landsat-7 missions; to provide information management, data distribution and a high level archive for the SAR data from the ERS-1/2, JERS-1 and RADARSAT spacecraft at the ASF; Independent Verification and Validation (IV&V) Support; V0/ADC Interoperability; V0 Interoperability; Version 0 Data Migration; and DAAC Site Activation.

The following objectives directly impact the PO.DAAC ECS.

<u>SeaWinds Support:</u> The second National Space Development Agency (NASDA) Japanese Advanced Earth Observing Satellite (ADEOS-II), scheduled for launch in August 1999, will carry the SeaWinds research instrument. The SeaWinds instrument is a space-borne scatterometer designed to make all-weather measurements of near-surface wind velocity over the world oceans. ECS will provide the science data processing, data archive and distribution functions of the SeaWinds Ground Data System at the JPL PO.DAAC. This includes ECS interfaces with the SeaWinds JPL SCF to support SeaWinds science data processing algorithm development and integration, as well as SeaWinds science data quality assurance. ECS will additionally interface with the Japanese ADEOS- II Ground Data System for the ingest of Level 0, Advanced Microwave Scanning Radiometer

(AMSR) and ancillary data. Due to its August 1999 launch schedule, ECS ADEOS-II support capabilities are planned for ECS Release B.

DFA Support: A dual frequency altimeter is scheduled for launch in 1999. The DFA instrument is a space-borne dual frequency altimeter designed to make highly-accurate ocean topography measurements. ECS will provide the science data processing, data archive anddistribution functions of the DFA Ground Data System at the JPL PO.DAAC. This includes ECS interfaces with the DFA JPL SCF to support DFA science data processing algorithm development and integration, as well as DFA science data quality assurance. ECS will additionally interface with the DFA Ground Data System for the ingest of Level 0 and ancillary data. With a planned launch date of 1999, ECS DFA support capabilities are planned for ECS Release B.

Independent Verification and Validation (IV&V) Support: Prior to the Release Readiness Review (RRR), the IV&V contractor can witness and/or monitor release acceptance testing and document nonconformances. Upon successful completion of the RRR, the IV&V contractor verifies that the ECS release operates correctly within the EOS Ground System (EGS). The ECS contractor, specifically the Independent Acceptance Test Organization (IATO), supports the IV&V contractor in this effort for a period of one month following RRR at the operational sites. The IATO coordinates personnel, facilities, and equipment support in the resolution of ECS nonconformances identified during IV&V testing. ECS contractor Maintenance and Operations personnel also support IV&V activities at operational centers, as necessary.

V0/ADC Interoperability: Two-way interoperability involves two different capabilities. First, outgoing interoperability allows users to log into the ECS and access ECS services, including the ability to access non-ECS data products from a site external to ECS directly from the ECS user interface. Second, incoming interoperability allows users, who are logged into a non-ECS site, to access ECS data products directly from the non-ECS user interface, using non-ECS IMS services. Both capabilities will be available in Release B.

Science Software Support: The initial Release dates are defined by hardware installation dependencies. The ECS project recommends that the required PGS hardware strings be made available several months prior to Version 1 delivery of the algorithms to allow independent SCF I&T before formal Science Software Test and Integration (SSI&T). Similarly, if new hardware is required for Version 2 algorithms, the hardware installations for a site must be in place several months in advance of an algorithm's Version 2 integration at that site.

In addition, to support full end-to-end testing of the algorithms, ECS infrastructure software (ancillary/auxiliary data ingest and preparation, DAAC-to-DAAC data transfers, Level 0 data validation, algorithm delivery, and algorithm product QA services) must be in place at the end of the Version 2 SSI&T for each instrument.

Building on Version 0: Building on Version 0 for a release implies that the release will be capable of matching (in general) the functionality of Version 0 plus adding some features that Version 0 does not have (i.e. “building on to” ,or enhancing, existing Version 0 capabilities). This does not mean the release will match every individual function/

capability of Version 0. It will be possible (through interoperability) to access some Version 0 functions, without having to make them part of ECS.

Version 0 (V0) Data Migration: Version 0 (V0) data migration includes the ability to transition V0 data sets from V0 to V1, and provide support, data management, search, and access capabilities for these data sets. A selected number of V0 data sets were made available at Release A at the Release A DAACs. Additional data migration takes place during Release B operations.

DAAC Site Activation: The EOSDIS DAACs have the mission of processing, archiving and distributing earth science data. While ECS will be helping the DAACs perform these functions in the Release B timeframe, many DAACs, like PO.DAAC, are currently performing these functions now.

The ECS contractor will schedule a series of site coordination trips to all DAACs. The objective of these trips is to ensure that the ECS contractor and the DAAC managers are in agreement with all operational issues. When ECS starts to deliver its systems to the sites, ECS works with the host organizations to ensure that hardware and software installation and segment and system testing all occur in a planned manner that is sensitive to the mission of the host organization. Coordination topics include facility requirements, locations of ECS equipment and personnel, installation and test periods, etc.

The issues of when, and to whom, training on ECS products is provided, is critical because of the potential impact on ECS operations and user support. Training on COTS hardware, software and application software, regardless of the development track, is an absolute necessity.

The facility access dates must be at least 2 months prior to the scheduled initial installation date to provide time for site verification inspection, completion of Government facility preparations, and receiving of COTS HW and SW. Installations of HW and SW take between 2 and 6 weeks depending on whether the site is an initial installation (requiring LAN installation) and the quantity and complexity of the configurations to be installed.

After installation, staffing and training of the maintenance and operations staff is accomplished. M&O training occurs in conjunction with the 3-month system integration and acceptance testing.

Another key objective is the ECS transition to Release B. The transition aspects of how this Release B site interoperates with the sites that are transitioning from A must be addressed. Reference the Transition to Release B Technical Paper (240-TP-010-002) for a more detailed discussion.

ECS subsystems provide mission and operations functionality for Release B. Key ECS related mission and operations activities supported by the JPL PO.DAAC ECS include information management, data distribution and a high level data archive.

In addition to automated support, ECS subsystems provide the capability for the ECS operations staff to perform a number of roles in support of these activities. These operational roles for the PO.DAAC are identified in Table 3.1.2-1. The table identifies the corresponding SDPS or CSMS subsystem that enables the DAAC ECS operations staff to perform a particular role or function. Detailed descriptions of these activities are captured in the ECS Operations Concept for the ECS Project: Part 2B - ECS Release B (604-CD-002-003) document. The Release B SDPS/CSMS Operations Scenarios Document (605-CD-002-001) provides additional detailed scenarios for these activities.

Table 3.1.2-1. PO.DAAC Operations Support Functions

ECS DAAC Operational Roles	Capability
User Services - Support user with data expertise - Generate and maintain data interface	Data Management Subsystem
Data Ingest - Monitor electronic - Handle media	Ingest Subsystem
Production Planning	Planning Subsystem
Resource Planning	Planning Subsystem Systems Management Subsystem
Production Monitoring and control	Processing Subsystem
Archive Management	Data Server Subsystem
Data Distribution - Monitor electronic - Handle media	Data Server Subsystem
S/W and H/W Maintenance	Office Support Systems Management Subsystem Communication Subsystem
Configuration Management (chg control)	Systems Management Subsystem
Testing, training, property management, integrated logistics support, library administration	Office Support Systems Management Subsystem Communication Subsystem
Resource Management	Processing, Ingest, Distribution & Data Server Subsystems in coordination with Systems Management Subsystem
Science Software Integration Support	Processing Subsystem
Database Maintenance	Data Management Subsystem Data Server Subsystem
System and Performance Analysis	Systems Management Subsystem
Security	Systems Management Subsystem
Accounting and Billing	Systems Management Subsystem
Sustaining Engineering	Office Support Systems Management Subsystem Communication Subsystem
S/W and H/W Maintenance	Office Support Systems Management Subsystem Communication Subsystem
Configuration Management (chg control)	Systems Management Subsystem
Testing, training, property management, integrated logistics support, library administration	Office Support Systems Management Subsystem Communication Subsystem

3.2 PO.DAAC External Interfaces

The PO.DAAC ECS will interface with multiple entities external to the DAAC. The ECS subsystem-specific DID305 design documents address the interfaces generically in a series of tables supported by textual explanations. For details, the reader is referred to those documents. Although planned, there are currently no ICDs for SeaWinds or DFA. Figure 3.2-1 schematically illustrates the interfaces between the ECS subsystems at the PO.DAAC and its external entities (sinks and sources of data). The figure enumerates data flows which are elaborated upon in Table 3.2-1.

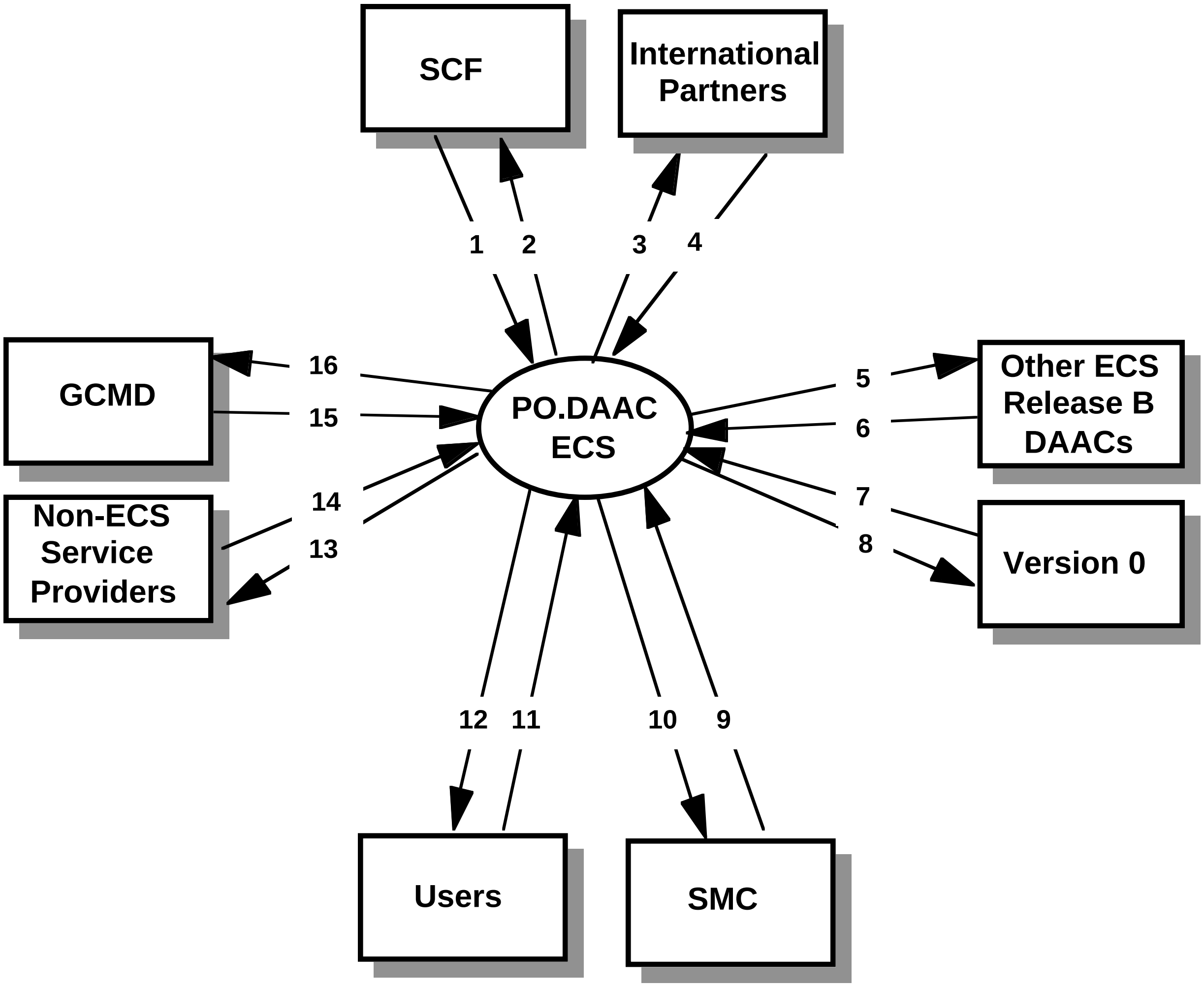

Figure 3.2-1. PO.DAAC ECS External Interfaces

A description of the external entities follows. The numbers in parenthesis refer to those in Figure 3.2-1.

- SeaWinds and DFA SCFs (1,2) –These interfaces are required for the SeaWinds and DFA science software integration and testing of the Version 1 and Version 2 science software. They are also required for the scientific quality assurance during SeaWinds and DFA data processing. SeaWinds and DFA science software, metadata, status, quality control products, standard products, calibration data, correlative data, science software updates and documentation will traverse this interface.
- International Partners (3,4) – These interfaces are required to provide two-way data transfer with the ADEOS-II Ground Data System for SeaWinds and for DFA. The SeaWinds interface is currently being defined. The scope of international participation in DFA has not yet been determined, and potential interfaces for DFA have not currently been defined.

- Other Release B DAACs (5,6) - The interfaces to the other ECS DAACs are required to support user requests for ECS data products not housed at the PO.DAAC. Also, all Release B data products that are migrated from their respective V0 DAACs will be available to the users. Guide, inventory, standard products and other related information, identified in Table 3-1, will flow across this interface.
- Version 0 (7,8) – This interface is required to provide V0/V1 cross-DAAC interoperability.
- SMC (9,10) - This interface provides the capability for the PO.DAAC to receive performance information, processing status, scheduling, and policy data and user registration information. Policy data includes that established by the ESDIS project. The PO.DAAC sends its system performance and status reports to SMC as part of this interface.
- Users (11,12) – This interface is the mechanism for user community access to ECS data and services. It is the mechanism by which advertisements, user registration, order and product status, desktop object manipulations, and command language capabilities are utilized.
- Non-ECS Service Providers (13,14) - This interface is required for specialized users who make use of ECS data to advertise and provide value-added services. These providers include commercial, institutional or other government agencies, as well as IPs, SCFs and ADCs.
- GCMD (15,16) - The Global Change Master Directory (GCMD) is a multidisciplinary database of information about data holdings of potential interest to the scientific research community. It contains high level descriptions of data set holdings of various agencies and institutions. It also contains supplementary descriptions about these data centers, as well as scientific campaigns and projects, data sources (e.g., spacecraft or instrument platforms) and sensors. This interface will allow the PO.DAAC to import directory level information from the GCMD via GCMD export files and generate ECS data product advertisements.

Table 3.2-1. PO.DAAC External Interfaces (1 of 4)

Flow No.	Source	Destination	Data Types	Data Volume	Frequency
1	SCF	Ingest	Metadata/updates	low	as required
1	SCF	Ingest	Documents	low	as required
1	SCF	Ingest	Algorithms/Updates	medium	as required
1	SCF	CSS (DAAC Ops via email)	Test Reviews by SCF	low	as required
1	SCF	CSS (DAAC Ops via email)	Request for Resource Usage	low	as required
1	SCF	CSS (DAAC Ops via email)	Reprocessing Request	low	as required
1	SCF	Data Server	QA Data request	low	as required
1	SCF	Data Server	QA Data Subscription	low	as required
2	Data Server	SCF	Status	low	as required
2	Data Server	SCF	Metadata/updates	low	as required
2	Data Server	SCF	Calibration data	medium	as required
2	Data Server	SCF	Correlative data	medium	as required
2	Data Server	SCF	Documents	low	as required
2	Data Server	SCF	Algorithms/updates	medium	as required
2	Data Server	SCF	Standard Products	medium	daily
2	CSS (DAAC Ops via email, EDHS)	SCF	Toolkit Delivery and Update Package	low	as required
2	CSS (DAAC Ops via email, kftp)	SCF	Test Results, QA, and Production History Data	low	as required
2	CSS (DAAC Ops via email, kftp)	SCF	Resource Usage	low	as required
2	CSS (DAAC Ops via email, kftp)	SCF	Status	low	as required
3	Data Server	IPs	Ancillary Data	medium	as required
3	Data Server	IPs	Correlative Data	medium	as required
3	Data Server	IPs	Level 0 - Level 4 Products	high	dependent on user input
3	Data Server	IPs	Metadata	low	dependent on user input
3	Data Server	IPs	Orbit/Attitude Data	low	infrequent
3	Data Server	IPs	Schedule Adjudication Data	low	as required
3	Data Server	IPs	Status	low	as required
3	Data Server	IPs	Documents	low	as required
3	Data Server	IPs	Calibration Data	medium	as required
4	SeaWinds	Ingest	Project Data Base Information	low	as required
4	SeaWinds	Ingest	History Data	medium	as required
4	SeaWinds	Ingest	Level 0 - Level 4 Products	high	daily

Table 3.2-1. PO.DAAC External Interfaces (2 of 4)

Flow No.	Source	Destination	Data Types	Data Volume	Frequency
4	SeaWinds	Ingest	Metadata	low	dependent on user input
4	SeaWinds	Ingest	Schedule Data	low	as required
4	SeaWinds	Ingest	Status	low	as required
4	SeaWinds	Ingest	Documents	low	as required
4	SeaWinds	Ingest	Calibration Data	medium	as required
4	SeaWinds	Ingest	Correlative Data	medium	as required
4	SeaWinds	Ingest	Ancillary Data	medium	as required
5	Other ECS DAACs	Data Server	Ancillary Data	high	as required
5	Other ECS DAACs	Data Server	Correlative Data	high	as required
5	Other ECS DAACs	Data Server	Calibration Data	medium	as required
5	Other ECS DAACs	Data Server	QA Data	medium	as required
5	Other ECS DAACs	Interoperability	Advertisements	medium	as required
5	Other ECS DAACs	Data Server	Result Sets	medium	as required
5	Other ECS DAACs	Client	Product Results	medium	as required
6	Data Server	Other ECS DAACs	Standard Products	high	as required
6	Data Server	Other ECS DAACs	Metadata	medium	as required
6	Data Server	Other ECS DAACs	Ancillary Data	high	as required
6	Data Server	Other ECS DAACs	Correlative Data	high	as required
6	Data Server	Other ECS DAACs	Calibration Data	high	as required
6	Data Server	Other ECS DAACs	Documents	medium	as required
6	Data Server	Other ECS DAACs	Orbit/Attitude Data	medium	as required
6	Data Server	Other ECS DAACs	Data Availability Schedules	medium	as required
6	Data Server	Other ECS DAACs	Algorithms	high	as required
6	Data Server	Other ECS DAACs	Special Products	high	as required
6	Data Server	Other ECS DAACs	Expedited or Validated Data	medium	as required
6	Data Server	Other ECS DAACs	QA Data	medium	as required
6	Interoperability	Other ECS DAACs	Advertisements	medium	as required
6	Client	Other ECS DAACs	Product Requests	medium	as required
7	Version 0 System	Data Server	Inventory	low	as required
7	Version 0 System	Data Server	Guide	low	as required

Table 3.2-1. PO.DAAC External Interfaces (3 of 4)

Flow No.	Source	Destination	Data Types	Data Volume	Frequency
7	Version 0 System	Data Server	Browse data	medium	as required
7	Version 0 System	Data Server	Dependent Valids	low	as required
7	Version 0 System	Data Management	V0 Directory search request	low	as requested
7	Version 0 System	Data Management	V0 Inventory search request	low	as requested
7	Version 0 System	Data Management	V0 browse request	low	as requested
7	Version 0 System	Data Management	V0 product order request	low	frequency dependent on user input
7	Version 0 System	Ingest	Migration Data	high	varies depending on migration strategy
8	Data Mgmt	Version 0 System	V0 Browse Result	low-medium	in response to ECS browse result
8	Data Mgmt	Version 0 System	V0 inventory result set	low-high	in response to ECS inventory result request
8	Data Mgmt	Version 0 System	V0 directory search result set	low-high	in response to ECS request
8	Data Mgmt	Version 0 System	V0 product order response	low	in response to product request result
8	Data Server	Version 0 System	Result Sets	medium-high	in response to request
8	Data Server	Version 0 System	Session Mgmt responses	low	in response to request
8	Data Server	Version 0 System	Product Request Status	low	as required
9	SMC	MSS	Policies	low	as required
9	SMC	MSS	Conflict Resolution	low	as required
9	SMC	MSS	Procedures	low	as required
9	SMC	MSS	Directives	low	as required
10	MSS	SMC	Conflict Resolution Request	low	as required
10	MSS	SMC	Status	low	as required
10	MSS	SMC	Performance	low	as required
11	Users	Client	User registration information	low	as requested
11	Users	Client	User login information	low	as requested
11	Users	Client	Search requests	low	as requested
11	Users	Client	Product requests	low	as requested
11	Users	Client	Acquisition requests	low	as requested
11	Users	Client	Desktop manipulate commands	low	as supplied by user
11	Users	Client	Configuration/Profile information	low	as supplied by user
11	Users	Client	Data manipulate requests	low	as requested

Table 3.2-1. PO.DAAC External Interfaces (4 of 4)

Flow No.	Source	Destination	Data Types	Data Volume	Frequency
11	Users	Client	Command language request	low	as requested
11	Users	Client	Advertisements, Software, and Documents	low	as supplied by user
11	Users	Ingest	User Methods	medium	as required
11	Users	Ingest	Ingest Status Requests	low	as required
12	Data Server	Users	Metadata	low	as requested
12	Data Server	Users	Documents	low	as requested
12	Data Server	Users	Data Products	medium	as requested
12	Data Server	Users	Browse Products	medium	as required
12	Data Server	Users	Product Request Status	low	as requested
12	Data Server	Users	Schedules	low	as requested
12	Client	Users	Results Set	medium	as requested
12	Client	Users	Application user interfaces	low	as requested
12	Client	Users	Formatted data	medium	as requested
12	Client	Users	Desktop Objects	low	as requested
12	Client	Users	Advertisement and Software	low	as requested
12	Client	Users	Error and Status information	low	as available
12	Ingest	Users	Ingest Status	low	as requested
13	Interoperability	Non-ECS Service Providers	Notifications	low	in response to subscriptions
14	Non-ECS Service Providers	Interoperability	Advertisements	low-medium	as required
14	Non-ECS Service Providers	Interoperability	Subscriptions	low	as required
15	GCMD	Interoperability	Advertisements	low-medium	as required
16	Interoper-ability	GCMD	Advertisements	low-medium	as required

In the table, where an exact number is unavailable, the data volume is estimated as low (less than 1 MB), medium (between 1 MB and 1 GB), or high (greater than 1 GB) per use defined in the frequency column .

3.3 Computer Software Component Analysis

The ECS software subsystems are described in detail in the ECS Subsystem-specific DID 305 documents. This section provides a brief overview description of each of the subsystems. Then the computer software configuration items (CSCIs) for each subsystem are addressed, focusing upon those CSCIs that are specific to the PO.DAAC ECS. For the most part, the software is the same for all ECS DAACs. However, the content of databases and schema constructions may differ. In addition, the purchase of different OTS packages for the DAACs may be required.

3.3.1 Software Subsystem Overview

The ten ECS software subsystems are described in detail in the ECS Subsystem-specific DID305 documents. This section provides a brief overview description of each of the subsystems.

Client Subsystem (CLS): This software consists of graphic user interface (GUI) programs, tools for viewing and/or manipulating the various kinds of ECS data (e.g., images, documents, tables) and libraries representing the client application program interface (API) of ECS services. The client subsystem components will be available to users for installation on their workstations and will also be deployed on workstations within the DAAC in support of normal operations, including User Services support.

<u>Interoperability Subsystem (IOS)</u>: The interoperability subsystem is an advertising service. It maintains a database of information about the services and data offered by ECS, and allows users to search through this database to locate services and data that may be of interest to them. The advertising service will be implemented as a Web server application with a DBMS back-end.

<u>Data Management Subsystem (DMS)</u>: This subsystem includes functions which provide uniform access to descriptions of the data and the data elements offered by the ECS repositories and provide a bi-directional gateway between ECS and Version 0. This subsystem also includes distributed search and retrieval functions and corresponding site interfaces.

<u>Data Server Subsystem (DSS)</u>: The subsystem provides the physical storage access and management functions for the ECS earth science data repositories. Other subsystems can access it directly or via the data management subsystem (if they need assistance with searches across several of these repositories). The subsystem also includes the capabilities needed to distribute bulk data via electronic file transfer or physical media. Other components include, for example, administrative software to manage the subsystem resources and perform data administration functions (e.g., to maintain the database schema); and data distribution software, e.g., for media handling and format conversions. The main components of the subsystem are the following:

- database management system - uses an off-the-shelf DBMS (Illustra) to manage it's earth science data and implement spatial searching, as well as for the more traditional types of data (e.g., system administrative and operational data). It will use a document management system to provide storage and information retrieval for guide documents, scientific articles, and other types of document data.
- file storage management systems - used to provide archival and staging storage for large volumes of data. Provides hierarchical storage support and device/media independence to the remainder of DSS and ECS.
- data type libraries - they will implement functionality of earth science and related data that is unique and not available off-the-shelf (e.g., spatial search algorithms and translations among coordinate systems). The libraries will interface with the data storage facilities, i.e. the database and file storage management systems.

<u>Ingest Subsystem (INS)</u>: The subsystem deals with the initial reception of all data received at an ECS facility and triggers subsequent archiving and processing of the data. Given the variety of possible data formats and structures, each external interface, and each ad-hoc ingest task may have unique aspects. Therefore, the ingest subsystem is organized into a collection of software components (e.g., ingest management software, translation tools, media handling software) from which those required in a specific situation can be readily configured. The resultant configuration is called an ingest client. Ingest clients can operate on a continuous basis to serve a routine external interface or they may exist only for the duration of a specific ad-hoc ingest task.

Data Processing Subsystem (DPS): The main components of the data processing subsystem - the science software - will be provided by the science teams. The data processing subsystem will provide the necessary hardware resources, as well as software for queuing, dispatching and managing the execution of the science software in an environment which will eventually be highly distributed and consist of heterogeneous computing platforms. The DPS also interacts with the DSS to cause the staging and de-staging of data resources in synchronization with processing requirements.

Planning Subsystem (PLS): This subsystem provides the functions needed to pre-plan routine data processing, schedule on-demand processing, and dispatch and manage processing requests. The subsystem provides access to the data production schedules at each site, and provides management functions for handling deviations from the schedule to operations and science users.

System Management Subsystem (MSS): The Management Subsystem (MSS) provides enterprise management (network, system and application management) for all ECS resources: commercial hardware (including computers, peripherals, and network routing devices), commercial software, and custom applications. Enterprise management reduces overall development and equipment costs, improves operational robustness, and promotes compatibility with evolving industry and government standards. Consistent with current trends in industry, the MSS thus manages both ECS's network resources per EBNET requirements and ECS's host/application resources per SMC requirements. Additionally MSS also supports many requirements allocated to SDPS and FOS for management data collection and analysis/distribution.

The MSS allocates services to both the system-wide and local levels. With few exceptions, the management services will be fully decentralized and no single point of failure exists which would preclude user access. In principle, every service is distributed unless there is an overriding reason for it to be centralized. MSS has two key specializations: Enterprise Monitoring and Coordination Services, and Local System Management Services.

Communications Subsystem (CSS): The CSS services include Object Services, Distributed Object Framework (DOF) and Common Facility Services. Support in this subsystem area is provided for peer-to-peer, advanced distributed, messaging, management, and event-handling communications facilities. These services typically appear on communicating end-systems across an internetwork and are not layered, but hierarchical in nature. Additionally, services to support communicating entities are provided, including directory, security, time, and other ancillary services. The services of the Communications Subsystem are functionally dependent on the services of the Internetworking Subsystem. The services of the common facility, object and DOF are the fundamental set of interfaces for all management and user access (i.e., pull) domain services.

Internetworking Subsystem (ISS): The Internetworking Subsystem provides for the transfer of data transparently within the DAACs, SMC and EOC, and for providing interfaces between these components and external networks. ECS interfaces with external systems and DAAC-to-DAAC communications are provided by the EOSDIS Backbone Network (EBnet). EBnet’s primary function is to transfer data between DAACs, including both product data and inter-DAAC queries and metadata responses. Other networks, such as

NSI, will provide wide-area services to ECS. In addition, "Campus" networks, which form the existing networking infrastructure at the ECS locations, will provide connectivity to EOSDIS components such as SCFs and ISTs.

3.3.2 Software Subsystem Analysis Summary

The subsystems that comprise SDPS and CSMS have already been described in detail in companion CDR documents. This section addresses the CSCIs from each subsystem and identifies their PO.DAAC ECS specifics. Generally, the software is the same for all ECS DAACs. The content of databases and schema constructions may differ. In the case of OTS packages the possibility arises for the purchase of different versions for different DAAC hardware but even this will be extremely minimal for Release B. In this section, each of the subsystems will be addressed in a somewhat general manner to point out whether or not there are any PO.DAAC specific portions.

- Client Subsystem - The client software will not have any PO.DAAC ECS-specific portions except for the possibility of different versions of OTS packages due to different types of hardware. Since the services offered by the client are required by operations, user services, and systems administrators, the PO.DAAC ECS will have clients installed on several different ECS furnished workstations. In addition the Physical Oceanography V0 DAAC may desire the client on some of their existing workstations to provide additional user access.
- Data Server - The software components of the Data Server Subsystem are largely the same for all Data Servers, at all DAACs. The two basic areas in which the Data Server Subsystem software will vary from DAAC to DAAC are configuration and special components.

  Data Server software is designed to be highly configurable in order to allow a wide variety of DAAC unique policy implementations. These unique configurations will enable the data server software installations to vary behavior, meeting the DAAC-specific needs. Examples of configuration parameters include number of concurrent connections, number of requests per client, inactivity timeout period and allocation of software components to hardware.

  Another facet of the Data Server Subsystem software that supports the specific DAAC capabilities is in which actual components are installed at the ECS portion of the DAAC. These opportunities for DAAC specificity are driven by the types of distribution available to the DAAC's data server clients and in the types of data (and their data type services) available. There will be portions of the Data Server software specific to the PO.DAAC that are used to add special devices for media distribution.

  However, the primary portion of the Data Server Subsystem software that will be specific to the PO.DAAC will be the specific data types supported at the DAAC. These software components are a portion of the Science Data Server (SDSRV) CSCI. The SDSRV is designed to allow complete flexibility in the data types (specifically, Earth Science Data Types, or ESDTs) that offer their services via the Data Server. Examples of services offered by ESDTs include Insert, Acquire, Browse and SpatialSubset. These data types are organized by separate CSCs, generally one per source instrument (.i.e., SeaWinds, DFA and MR). Additional information about the JPL instruments can be found in the ECS Technical baseline.

- Data Management - None of the data management software will be unique to the PO.DAAC ECS. The V0 Gateway (GTWAY) will interface with the data servers at each site. Local and cross-DAAC searches on V0 DAAC's data holdings are provided via capabilities resulting from integrating the components from the V0 System IMS into ECS.
- Ingest - The software portions for ingest at the PO.DAAC ECS may differ from those of other ECS DAACs because of dataset dependencies and differences related to non-homogeneous computer hardware across the Release B DAACs. Data ingestion procedures must match the peculiarities of the ingested data sets. Several types of ingest clients are described in the Data Server Subsystem companion document. The primary client was based on an approach used by TRMM SDPF.
- Interoperability - There are no PO.DAAC ECS specific portions of the Interoperability Subsystem .
- Production Planning - The actual development code and OTS packages required for the PO.DAAC ECS will be generic, however, there will be a considerable amount of configuration and database information that will be specific. Scripts, while they may use the same language, will be different and will trigger different responses in response to faults and other error conditions .
- Data Processing - Due to dataset characteristics there will be some specific software for the PO.DAAC ECS in the area of Science Data Processing. In addition, as with the data server and ingest subsystems, differences in hardware types, driven by algorithm requirements, will also result in some differences in software.
- Communications Subsystem - There are no PO.DAAC ECS specific portions of this subsystem.
- Systems Management - This subsystem is composed of a variety of management applications, providing services such as fault, performance, security and accountability management for ECS networks, hosts, and applications. Two tiers of "view" (domain of management service interface) provided by the applications in this subsystem. Only the local management view is provided at the PO.DAAC ECS. There are no PO.DAAC ECS specific portions of this subsystem.
- Internetworking Subsystem - There are no PO.DAAC ECS specific portions of this subsystem.

Table 3.3.2-1 lists the ECS subsystems and associated CSCIs and CSCs. For each CSC, there is an indication of the type of component. As defined in the DID 305 subsystem-specific documents, type indicates whether the component is custom developed (DEV), off the shelf (OTS), a CSC reused from another subsystem (reuse), a wrapper (WRP) that encapsulates OTS, or a combination of these types. The Use column indicates whether a generic-for-all-DAACs (Gnrc) form of the CSC is implemented or specific (Spf) tailoring or use is required at a DAAC. The Notes column is included to comment about the characteristics of the system, data, and/or software that makes the CSC specific, as well as to provide any additional information about the generic CSCs. The OTS products are also listed in this column.

Table 3.3.2-1. PO.DAAC Components Analysis (1 of 9)

Subsystem	CSCI	CSC	TYPE	USE	NOTES
Client	DESKT	Desktop Manager	DEV	Gnrc	
Client	WKBCH	Comment/Survey Tool	OTS/ DEV	Gnrc	WWW Browser
Client	WKBCH	Data Acquisition Request Tool	DEV	Gnrc	
Client	WKBCH	Data Dictionary Tool	DEV	Gnrc	
Client	WKBCH	Document Search Tool	OTS	Reuse	CSS-provided
Client	WKBCH	Earth Science Search Tool	DEV	Gnrc	
Client	WKBCH	E-mailer Tool	OTS	Reuse	CSS-provided
Client	WKBCH	Hypertext Authoring Tool	OTS	Gnrc	MS Office / TBD public domain
Client	WKBCH	Hypertext Viewer	OTS	Gnrc	WWW Browser
Client	WKBCH	Logger/Reviewer Tool	DEV	Gnrc	
Client	WKBCH	News Reader Tool	OTS	Reuse	CSS-provided
Client	WKBCH	Product Request Tool	DEV	Gnrc	
Client	WKBCH	Session Management Tool	DEV	Gnrc	
Client	WKBCH	User Preferences Tool	DEV	Gnrc	
Client	WKBCH	User Registration Tool	DEV	Gnrc	
Client	WKBCH	Visualization Tool	DEV	Gnrc	
Communication	DCCI	Bulletin Board	OTS	Reuse	CSS-provided
Communication	DCCI	Directory/Naming Services	OTS/ DEV	Gnrc	OODCE
Communication	DCCI	Distributed File System (DFS)	OTS	Gnrc	DCE
Communication	DCCI	DOF Services	OTS	Gnrc	OODCE
Communication	DCCI	Electronic Mail Services	OTS/ DEV	Gnrc	native operating system
Communication	DCCI	Event Logger Services	OTS/ DEV	Gnrc	DCE
Communication	DCCI	File Access Services	OTS/ DEV	Gnrc	ftp, kftp, DCE
Communication	DCCI	Life Cycle Services	OTS/ DEV	Gnrc	OODCE
Communication	DCCI	Message Passing Services	OTS/ DEV	Gnrc	Developed with OODCE
Communication	DCCI	Security Services	OTS/ DEV	Gnrc	OODCE
Communication	DCCI	Thread Services	OTS	Gnrc	OODCE
Communication	DCCI	Time Services	OTS/ DEV	Gnrc	OODCE
Communication	DCCI	Virtual Terminal Services	OTS	Gnrc	native operating system
Data Management	DDICT	Client Library	DEV	Gnrc	
Data Management	DDICT	Configuration/Setup	DEV	Gnrc	
Data Management	DDICT	DBMS Server	OTS	Gnrc	Sybase DBMS

Table 3.3.2-1. PO.DAAC Components Analysis (2 of 9)

Subsystem	CSCI	CSC	TYPE	USE	NOTES
Data Management	DDICT	Maintenance Tool	DEV	Gnrc	
Data Management	DDICT	Persistent Data	DEV	Gnrc	
Data Management	DDICT	Request Processing	DEV	Gnrc	
Data Management	DDICT	Server	DEV	Gnrc	
Data Management	DIMGR	Configuration/Setup	DEV	Gnrc	
Data Management	DIMGR	Server	DEV	Gnrc	
Data Management	GTWAY	Configuration/Setup	DEV	Gnrc	
Data Management	GTWAY	Server	DEV	Gnrc	
Data Management	GTWAY	V0 Back End	OTS	Gnrc	From V0
Data Management	GTWAY	V0 Client Interface	DEV	Gnrc	
Data Management	GTWAY	V0 External Interface	DEV	Gnrc	
Data Management	GTWAY	V0 Front End	OTS	Gnrc	From V0
Data Management	LIMGR	Client Library	DEV	Gnrc	
Data Management	LIMGR	Configuration/Setup	DEV	Gnrc	
Data Management	LIMGR	Database Interface	OTS	Gnrc	RogueWave DBTools
Data Management	LIMGR	External Interface	DEV	Gnrc	
Data Management	LIMGR	Mapping Layer	DEV	Gnrc	
Data Management	LIMGR	Request Processing	DEV	Gnrc	
Data Management	LIMGR	Server	DEV	Gnrc	
Data Processing	AITTL	Binary File Comparison Utility	DEV	Gnrc	
Data Processing	AITTL	Code Analysis Tools	OTS	Spfc	CASEVision SPARCWorks Specific for science software language.
Data Processing	AITTL	Data Visualization Tools	OTS DEV	Gnrc	IDL
Data Processing	AITTL	Documentation Viewing Tools	OTS	Gnrc	SoftWindows/MS Office Ghostview
Data Processing	AITTL	ECS HDF Visualization Tools	DEV	Gnrc	Reused from Client subsystem, WKBCH CSCI, Data Visualization (EOSView) CSC
Data Processing	AITTL	HDF File Comparison Utility	DEV OTS	Gnrc	Custom IDL program
Data Processing	AITTL	PGE Processing GUI	DEV	Gnrc	
Data Processing	AITTL	PGE Registration GUI	DEV	Gnrc	
Data Processing	AITTL	Product Metadata Display Tool	Reuse	Gnrc	Reused from Data Processing subsystem, AITTL CSCI, HDF File Comparison Utility CSC
Data Processing	AITTL	Profiling Tools	OTS	Spfc	CASEVision Specific for science software language.

Table 3.3.2-1. PO.DAAC Components Analysis (3 of 9)

Subsystem	CSCI	CSC	TYPE	USE	NOTES
Data Processing	AITTL	Report Generation Tools	OTS/ DEV	Gnrc	OTS: SoftWindows/MS Office, Dev: SSI&T manager
Data Processing	AITTL	SDP Toolkit-related Tools	DEV	Gnrc	
Data Processing	AITTL	SSAP Processing GUI	DEV	Gnrc	
Data Processing	AITTL	Standards Checkers	OTS/ DEV	Spfc	FORCHECK for Fortran 77; otherwise, native compilers and UNIX lint. Specific for science software language.
Data Processing	AITTL	Update Data Server GUI	DEV	Gnrc	
Data Processing	AITTL	Update PGE Database GUI	DEV	Gnrc	
Data Processing	PRONG	COTS	OTS	Gnrc	AutoSys and AutoXpert.
Data Processing	PRONG	COTS Management	DEV	Gnrc	
Data Processing	PRONG	Data Management	DEV	Gnrc	
Data Processing	PRONG	Data Pre-Processing	DEV	Spfc	Specific based on uniqueness of ancillary data products
Data Processing	PRONG	PGE Execution Manage-ment	DEV	Gnrc	
Data Processing	PRONG	Quality Assurance Monitor Interface	DEV/ OTS	Spfc	Specific based on uniqueness of Science software and SCF-DAAC relationship
Data Processing	PRONG	Resource Management	DEV	Gnrc	
Data Processing	SDPTK	Ancillary Data Access	DEV	Gnrc	
Data Processing	SDPTK	Celestial Body Position	DEV	Gnrc	
Data Processing	SDPTK	Constant and Unit Conver-sions	DEV/ OTS	Gnrc	UDUNITS freeware
Data Processing	SDPTK	Coordinate System Conver-sion	DEV	Gnrc	
Data Processing	SDPTK	EOS-HDF	DEV	Gnrc	
Data Processing	SDPTK	Error/Status Handling	DEV	Gnrc	
Data Processing	SDPTK	Geo Coordinate Transforma-tion	DEV OTS	Gnrc	GCTP (USGS)
Data Processing	SDPTK	Graphics Library	OTS	Gnrc	IDL
Data Processing	SDPTK	File Input/Output Tools	DEV OTS	Gnrc	NCSA HDF
Data Processing	SDPTK	Math Package (IMSL)	OTS	Gnrc	IMSL
Data Processing	SDPTK	Memory Management	DEV	Gnrc	
Data Processing	SDPTK	Metadata Access	DEV	Gnrc	
Data Processing	SDPTK	Process Control	DEV	Gnrc	
Data Processing	SDPTK	Spacecraft Ephemeris and Attitude Access	DEV	Gnrc	

Table 3.3.2-1. PO.DAAC Components Analysis (4 of 9)

Subsystem	CSCI	CSC	TYPE	USE	NOTES
Data Processing	SDPTK	Time Date Conversion	DEV	Gnrc	
Data Server	DDIST	Distribution Client Interface	DEV	Gnrc	
Data Server	DDIST	Distribution Products	DEV	Gnrc	
Data Server	DDIST	Distribution Request Management	DEV	Gnrc	
Data Server	DDSRV	DDSRV	DEV/ OTS	Gnrc	RogueWave class libraries
Data Server	DDSRV	DDSRV Client	DEV/ OTS	Gnrc	OODCE; RogueWave class libraries
Data Server	DDSRV	DDSRV CSDT	DEV/ OTS	Gnrc	RogueWave class libraries
Data Server	DDSRV	DDSRV ESDT	DEV/ OTS/ Reuse	Gnrc	Reuse from SDSRV; RogueWave class libraries
Data Server	DDSRV	DDSRV Search Engine	DEV/ OTS	Gnrc	Topic and Netscape server
Data Server	DDSRV	DDSRV Server	DEV	Gnrc	Topic API; RogueWave class libraries
Data Server	DDSRV	Gateway	DEV/ OTS	Gnrc	Netscape libraries
Data Server	SDSRV	Administration and Operations	DEV	Gnrc	RogueWave class libraries
Data Server	SDSRV	Client	DEV/ OTS	Gnrc	OODCE; RogueWave class libraries
Data Server	SDSRV	Configuration and Startup	DEV	Gnrc	RogueWave class libraries
Data Server	SDSRV	CSDT	DEV OTS	Gnrc	HDF-EOS
Data Server	SDSRV	DB Wrappers	DEV OTS	Gnrc	Illustra DBMS server and API
Data Server	SDSRV	Descriptors	DEV	Gnrc	RogueWave class libraries
Data Server	SDSRV	General ESDT	DEV	Gnrc	RogueWave class libraries
Data Server	SDSRV	Global	DEV/ OTS	Gnrc	RogueWave class libraries
Data Server	SDSRV	GUI	DEV OTS	Gnrc	RogueWave class libraries; X-11/Motif
Data Server	SDSRV	Metadata	DEV/ Wrpr	Gnrc	Illustra DBMS API
Data Server	SDSRV	Non-Product Science ESDT	DEV	Gnrc	RogueWave class libraries
Data Server	SDSRV	Non-Science ESDT	DEV	Gnrc	RogueWave class libraries
Data Server	SDSRV	SeaWinds	DEV	Spfc	ESDTs - SWS
Data Server	SDSRV	DFA	DEV	Spfc	ESDTs - DFA

Table 3.3.2-1. PO.DAAC Components Analysis (5 of 9)

Subsystem	CSCI	CSC	TYPE	USE	NOTES
Data Server	SDSRV	MR	DEV	Spfc	ESDTs - MR
Data Server	SDSRV	Server	DEV/ OTS	Gnrc	RogueWave class libraries
Data Server	SDSRV	Subscriptions	DEV/ OTS	Gnrc	RogueWave class libraries
Data Server	STMGT	Data Storage	DEV/ OTS	Gnrc	AMASS File Storage Management System
Data Server	STMGT	File	DEV	Gnrc	
Data Server	STMGT	Peripherals	DEV	Gnrc	This CSC encapsulates the CSS-supplied API which supports the OTS FTP product.
Data Server	STMGT	Resource Management	DEV	Gnrc	
Data Server	STMGT	Service Clients	DEV/ OTS	Gnrc	CSC encapsulates the AMASS OTS product (Data Server subsystem, STMGT CSCI, Data Storage CSC) . Also Rogue Wave class libraries.
Ingest	INGST	Client	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	Configuration/ Startup	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	CSDT	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	Data Storage	Reuse	Gnrc	Reused from Data Server subsystem, STMGT CSCI
Ingest	INGST	DB Wrappers	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	Descriptors	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	Distribution Client Interface	Reuse	Gnrc	Reused from Data Server subsystem, DDIST CSCI
Ingest	INGST	Distribution Products	Reuse	Gnrc	Reused from Data Server subsystem, DDIST CSCI
Ingest	INGST	Distribution Request Management	Reuse	Gnrc	Reused from Data Server subsystem, DDIST CSCI

Table 3.3.2-1. PO.DAAC Components Analysis (6 of 9)

Subsystem	CSCI	CSC	TYPE	USE	NOTES
Ingest	INGST	File	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	General ESDT	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	Global	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	GUI	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	Ingest Administration Data	DEV	Gnrc	
Ingest	INGST	Ingest Data Preprocessing	DEV	Spfc	Specific based on uniqueness of ingested data and preprocessing requirements.
Ingest	INGST	Ingest Data Transfer	DEV	Gnrc	
Ingest	INGST	Ingest DBMS	OTS	Gnrc	Sybase DBMS
Ingest	INGST	Ingest Request Processing	DEV	Gnrc	
Ingest	INGST	Ingest Session Manager	DEV	Gnrc	
Ingest	INGST	Metadata	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	Non-Product Science ESDTs	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	Non-Science ESDTs	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	SeaWinds	Reuse	Spcf	ESDTs-SWS; Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	DFA	Reuse	Spcf	ESDTs-DFA; Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	MR	Reuse	Spcf	ESDTs-MR; Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	Operator Ingest Interfaces	DEV	Gnrc	
Ingest	INGST	Polling Ingest Client Interface	DEV	Gnrc	
Ingest	INGST	Resource Management	Reuse	Gnrc	Reused from Data Server subsystem, STMGT CSCI

Table 3.3.2-1. PO.DAAC Components Analysis (7 of 9)

Subsystem	CSCI	CSC	TYPE	USE	NOTES
Ingest	INGST	Server	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	Service Clients	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	Subscriptions	Reuse	Gnrc	Reused from Data Server subsystem, SDSRV CSCI
Ingest	INGST	User Network Ingest Interface	DEV	Gnrc	
Ingest	INGST	Viewing Tools	Reuse	Gnrc	Reused from Client subsystem, WKBCH CSCI, Data Visualization (EOSView) CSC
Interoperability	ADSRV	AdvNavigationServer	OTS	Gnrc	HTTP server
Interoperability	ADSRV	Client Library	DEV	Gnrc	
Interoperability	ADSRV	Core Library	DEV	Gnrc	
Interoperability	ADSRV	HTML Framework	DEV	Gnrc	
Interoperability	ADSRV	HTML Interfaces	DEV	Gnrc	
Interoperability	ADSRV	Installer	DEV	Gnrc	
Interoperability	ADSRV	Persistent Object Framework	DEV	Gnrc	
Internetworking	INCI	Datalink/Physical	OTS	Gnrc	firmware, vendor-supplied with hardware
Management	MACI	Application MIB	DEV	Gnrc	
Management	MACI	ECS Subagent	DEV	Gnrc	
Management	MACI	Encapsulator for non-Peer Agent	OTS/ DEV	Gnrc	OptiMate
Management	MACI	Extensible SNMP Master Agent	OTS/ DEV	Gnrc	Peer Network's agent, along with its toolkit for Dev
Management	MACI	Instrumentation Class Library	DEV	Gnrc	
Management	MACI	Management Agent Services	OTS/ DEV	Gnrc	Peer and Tivoli/Sentry
Management	MACI	Proxy Agent	DEV	Gnrc	
Management	MACI	SNMP Manager's Deputy	DEV	Gnrc	
Management	MCI	Accountability	DEV	Gnrc	
Management	MCI	Application Management	DEV	Gnrc	
Management	MCI	Automatic Actions	DEV	Gnrc	
Management	MCI	Billing and Accounting Management	OTS/ DEV	Gnrc	ITS selection in progress
Management	MCI	DCE Cell Management	OTS	Gnrc	HP Account Manager Toolr
Management	MCI	Diagnostic Tests	OTS	Gnrc	vendor-supplied with hardware

Table 3.3.2-1. PO.DAAC Components Analysis (8 of 9)

Subsystem	CSCI	CSC	TYPE	USE	NOTES
Management	MCI	Fault Management	OTS/ DEV	Gnrc	Tivoli and HP Open-View
Management	MCI	Management Data Access	DEV	Gnrc	
Management	MCI	Management Data Access User Interface	DEV	Gnrc	
Management	MCI	Management Framework	OTS	Gnrc	HP OpenView Network Node Manager
Management	MCI	Management Proxy	DEV	Gnrc	
Management	MCI	Mode Management	DEV	Gnrc	
Management	MCI	Network Manager	OTS	Gnrc	HP OpenView Network Node Manager
Management	MCI	Performance Management	OTS/ DEV	Gnrc	RFP released
Management	MCI	Performance Management Proxy	DEV	Gnrc	
Management	MCI	Performance Test	OTS	Gnrc	vendor-supplied with hardware
Management	MCI	Physical Configuration Management	OTS	Gnrc	Mountain View
Management	MCI	Physical Configuration Proxy Agent	DEV	Gnrc	
Management	MCI	Report Generation	OTS	Gnrc	No decision yet, evaluation in progress
Management	MCI	Report Generation and Distribution	DEV	Gnrc	
Management	MCI	Report Generation Manager	DEV	Gnrc	
Management	MCI	Resource Class Category	DEV	Gnrc	
Management	MCI	Security Databases	OTS	Gnrc	Operating System Password Files, DCE Registry Database, Router Configuration Files, TCP Wrappers configuration files, Operating System Access Control Lists, DCE Access Control Lists
Management	MCI	Security Management	DEV	Gnrc	
Management	MCI	Security Management Proxy	DEV	Gnrc	
Management	MCI	Security Tests	OTS	Gnrc	CRACK, COPS, SATAN, TRIPWIRE
Management	MCI	Trouble Ticketing Management Service	OTS	Gnrc	Remedy Action Request System
Management	MCI	Trouble Ticketing Proxy Agent	DEV	Gnrc	
Management	MCI	Trouble Ticketing Service Requester	DEV	Gnrc	

Table 3.3.2-1. PO.DAAC Components Analysis (9 of 9)

Subsystem	CSCI	CSC	TYPE	USE	NOTES
Management	MCI	Trouble Ticketing User Interface	DEV	Gnrc	
Management	MCI	User Contact Tool	OTS/ DEV	Gnrc	Remedy
Management	MCI	User Profile Server	DEV	Gnrc	
Management	MLCI	Baseline Manager	OTS/ DEV	Gnrc	XRP II
Management	MLCI	Configuration Management	OTS	Gnrc	ClearCase
Management	MLCI	Inventory/Logistics/ Maintence (ILM) Manager	OTS/ DEV	Gnrc	Vendor evaluation in progress
Management	MLCI	Policies and Procedures Management	DEV	Gnrc	
Management	MLCI	Software Change Manager	OTS/ DEV	Gnrc	ClearCase
Management	MLCI	Software Distribution Management Structure	OTS/ DEV	Gnrc	ClearCase and Tivoli
Management	MLCI	Software Request Manager	OTS/ DEV	Gnrc	DDTS
Management	MLCI	Training Management	DEV	Gnrc	
Planning	PLANG	On Demand Manager	DEV	Gnrc	
Planning	PLANG	PDPS DBMS	OTS/ DEV	Gnrc	Sybase DBMS
Planning	PLANG	Planning Object Library	OTS	Gnrc	Delphi C++ class libraries
Planning	PLANG	Production Planning Workbench	DEV	Gnrc	
Planning	PLANG	Production Request Editor	DEV	Gnrc	
Planning	PLANG	Resource Planning Workbench	DEV	Gnrc	
Planning	PLANG	Subscription Editor	DEV	Gnrc	
Planning	PLANG	Subscription Manager	DEV	Gnrc	

3.4 DAAC Hardware and Network Design

This section describes the ECS hardware and local area network design supporting the Release B ECS mission at the JPL DAAC. Section 3.4.1 contains an overview diagram from the "networks" point of view, and detailed descriptions of the Release B LANs. Section 3.4.2 contains a hardware overview diagram of all of the ECS subsystems at JPL, followed by detailed descriptions and rationale for each subsystem.

3.4.1 JPL DAAC LAN Configuration

The JPL DAAC LAN topology is illustrated in Figure 3.4.1-1. The topology consists of a User FDDI Network and a Production FDDI Network. A HiPPI Network is not required due to the moderate data flows between Data Server and Processing. The creation of separate User and Prduction networks allows processing flows to be unaffected by user pull demands. Each of the networks is discussed in detail below.

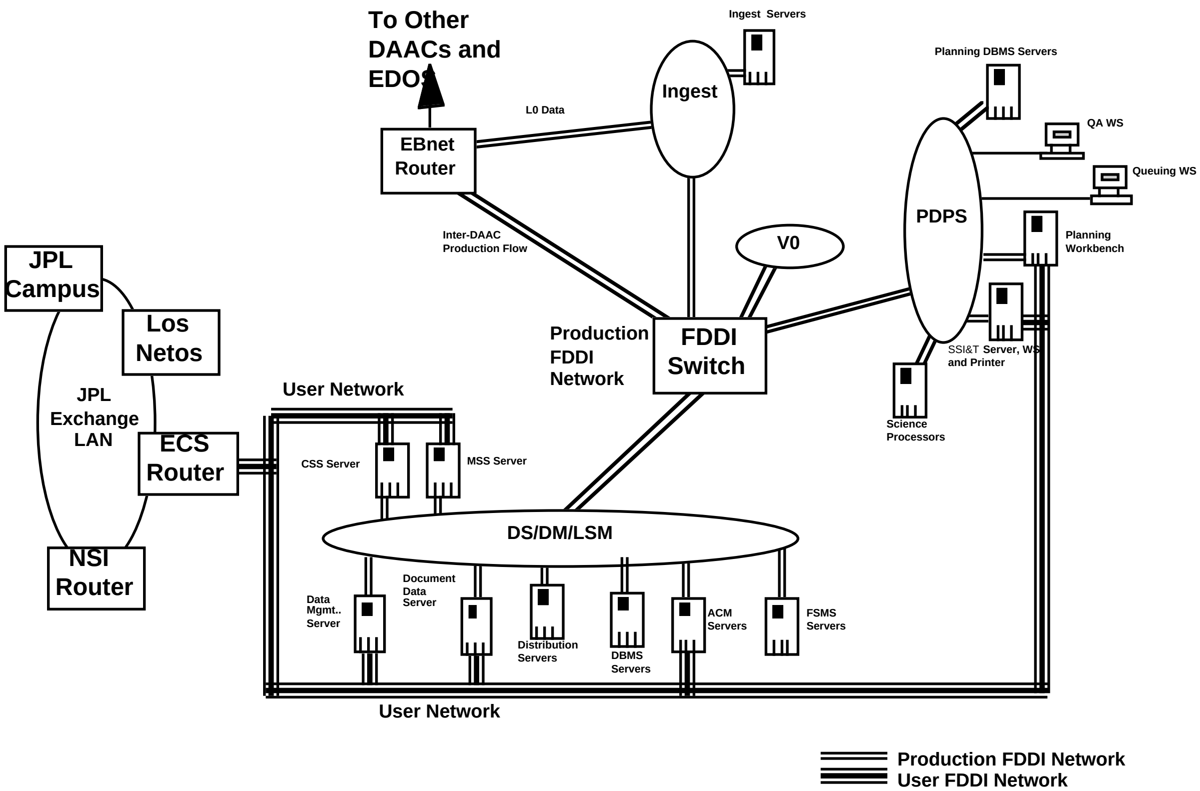

Figure 3.4.1-1. JPL DAAC LAN Topology

The Production Network consists of multiple FDDI rings supporting the DAAC subsystems and connections to external production systems (such as EDOS and other ECS DAACs) via EBnet. The separation and aggregation of hosts and subsystems onto FDDI rings is driven mostly by RMA and data flow requirements. For instance, Ingest is contained on an individual FDDI ring because of the strict RMA requirement for receipt of Level 0 data (0.998 with MDT of 15 minutes). RMA also dictates Ingest's direct connection to the EBnet router. Some Data Server and Processing hosts are contained on dedicated a FDDI ring in order to provide adequate bandwidth for the DAAC-to-DAAC processing flow requirements (see table 3.4.1.1-1 below). The DM, LSM, and some Data Server hosts are contained on a single ring because their flows are expected to be fairly small given that user traffic will be processed on the separate User Network (see discussion below). Another ring provides access to the EBnet router to handle the DAAC-DAAC production flows. The FDDI Switch is the central device connecting the FDDI rings together, and it provides the necessary routing and filtering control.

The User Network is an FDDI-based LAN connecting users (via NSI, local campuses, general Internet, etc.) to the DAAC hosts responsible for providing user access. It has the main advantage of separating user and production flows. This allows DAAC processing data flows to be unaffected by user demand, so that even unanticipated user pull will not hinder the production network. Basically, the User Network provides access to Data Manager hosts and to a subset of Data Server hosts that interact directly with users. Users will not have access to any other hosts, such as Ingest or Processing devices. The CSS and MSS servers are connected to the User Network but will not allow direct user access. These connections are required for communications with outside networks for such things as name lookups and receipt of Internet mail, as well as communication with and monitoring of the DAAC's interfaces to the user community (such as NSI and the local campus).

The User Network will connect to the JPL Exhange LAN through an ECS router which will provide the necessary routing and filtering controls. NSI, the local JPL Campus, and other Internet providers such as LosNetos will also be connected to the JPL exchange LAN. ECS will have a direct connection to V0 via the production FDDI switch. This interface will be used for V0 data migration; V0 will have a separate connection to EBnet for other traffic flows.

Individual FDDI rings for the Production Network will be implemented with FDDI concentrators to provide ease of wiring and central points of management. All Production Network DAAC hosts will have FDDI interfaces and will be attached directly to the FDDI rings. Workstations will have single-attached FDDI cards, whereas the high-performance servers and processors on the Production Network will have dual-attached FDDI cards to provide redundancy. Dual-attached hosts will be dual-homed to two separate FDDI concentrators to provide an additional level of redundancy in the event of a hub failure. Interfaces of User Network hosts will be single-attached, except for the Data Management Server, which will be dual-attached. Printers, and X-terminals will be connected to the DS/DM/LSM FDDI ring via an FDDI-to-Ethernet hub.

Quantities of networking hardware components for the JPL DAAC during Release B are presented in Table 3.4.1-1.

Table 3.4.1-1. Rel. B Networking Hardware for JPL DAAC LAN

Networking Component	Quantity	Comments
FDDI Concentrator	10	Bay Networks 2914-04 concentrator with 12 M & 1 A/B port
FDDI Cables	90	Multimode fiber cables with MIC connectors
FDDI-to-Ethernet Hub	1	Cabletron MicroMMAC-22E; used for printers and X-terminals
Ethernet Cables	8	10baseT connection to printers and X-terminals
FDDI Switch/Router	1	Interconnects Production Network
FDDI Router	1	Interconnects User Network

3.4.1.1 Sizing/Performance Rationale

The data flow estimates used as input to the design process for the JPL DAAC LAN topology are contained in Table 3.4.1.1-1. The table, based on static analysis of the February 1996 AHWGP baseline (results for epoch k 3Q99) and the February 1996 User Pull Baseline (results for the greater of July 1999 and January 2000), is arranged according to the source and sink of the flow.

It provides both raw 24-hour average data flows (including any applicable reprocessing) which are the output of ECS models, as well as weighted flows containing all overhead and contingency factors. The "Factors Applied" column shows which factors (listed beneath the table) were applied to each data flow.

Table 3.4.1.1-1. Estimated Rel. B Data Flows for the JPL DAAC

Major Data Flow Description *	Raw Volume (in Mbps)	Factors Applied	Weighted Volume (in Mbps)
FSMS Server to Processing	2.5	1,2,3,4,5,6	35.5
FSMS Server to Distribution Server	14.4	2,3,4,5	40.5
ACM Server to/from other DAACs	< 0.1	1,2,3,4,5,6	0.1
User Pull	1.3	2,3,4,5	3.7

* Other flows such as session establishments amongst the subsystem hosts and subsystems to and from MSS are trace amounts and are not included in the table.

Overhead Factors:
(1) SSI&T Factor: 1.2. This factor not applied to User flows. Accounts for capacity for integration and test flows.
(2) TCP/IP/FDDI Protocol Overhead: 1.25. Accounts for overhead associated with FDDI, IP, TCP, and other protocols (such as DCE).
(3) FDDI Maximum Circuit Utilization Factor: 1.25. Accounts for amount of 100 Mbps bandwidth that is actually usable for sustained data rates.
(4) Average-to-peak Conversion Factor: 1.5. This provides elasticity in the network by converting the 24 hour averages provided by the model into peaks.
(5) Scheduling Contingency: 1.2. This reflects the ability for the network to recover within 24 hours from a 4 hour down-time (24/20=1.2).
(6) Operational Hours Factor: 4.2 at JPL. Accounts for percentage of day/week operations are performed. This factor is applied only to production flows, not to user flows.

3.4.2 DAAC Hardware Configuration

The ECS DAAC hardware suite at JPL hosts the Data Server, Data Management, Ingest, Interoperability, Production/Planning, Science Data Processing, Management and Communications subsystems. The hardware and COTS software selected for the JPL configuration is illustrated in Figure 3.4.2-1, JPL ECS DAAC Hardware Configuration Diagram. These configurations represent the candidate hardware selections which most closely satisfy the processing, storage capacities and communications bandwidth requirements described in the following sections. In some cases the selected configuration appears to significantly exceed the requirements due to the sizing increments provided by the selected vendor, when in reality, our analysis and selection process has provided cost effective solutions to each problem.

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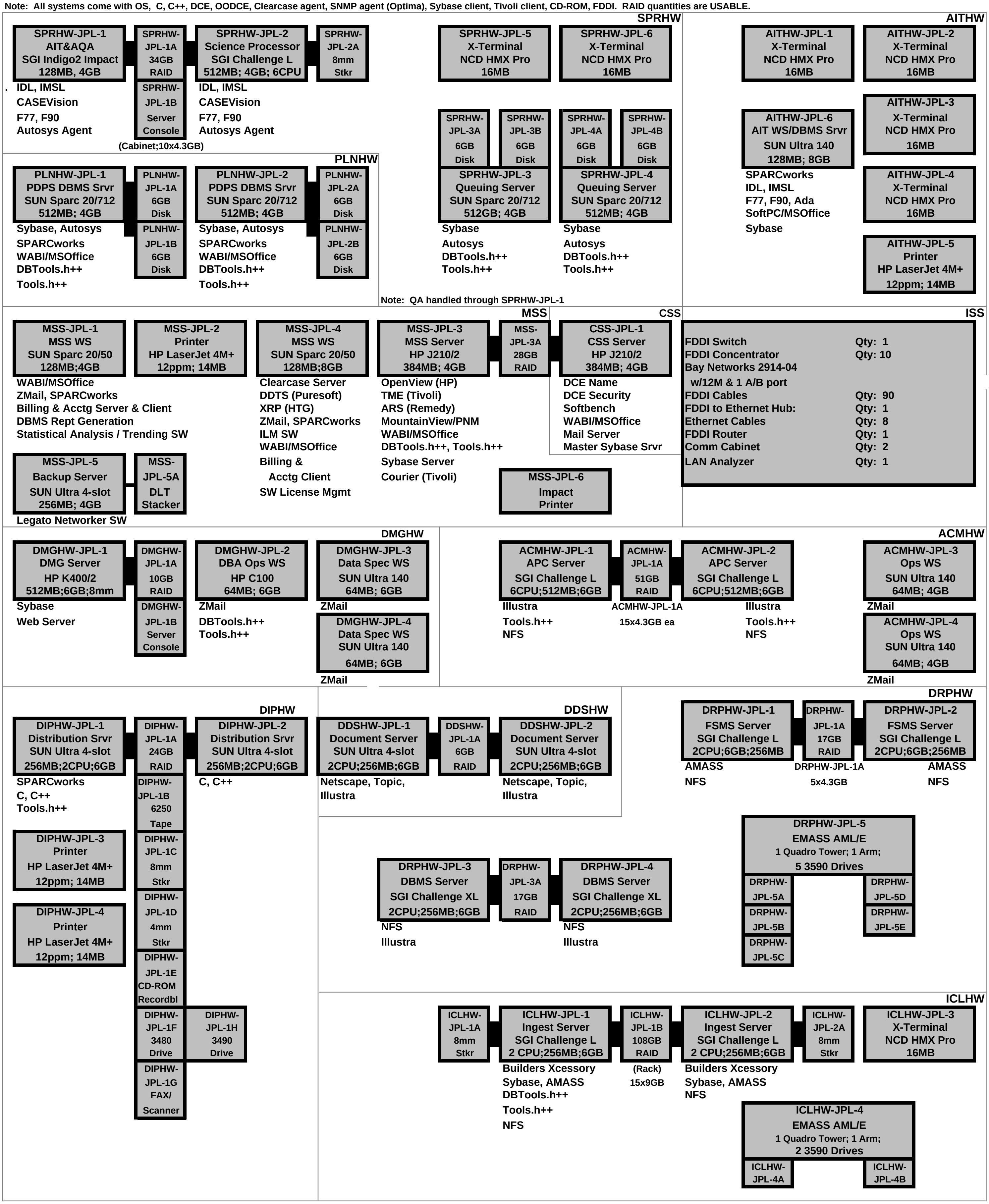
Figure 3.4.2-1. JPL Hardware Configuration Diagram

JPL at Rel B

Added for Release B

Note: All systems come with OS, C, C++, DCE, OODCE, Clearcase agent, SNMP agent (Optima), Sybase client, Tivoli client, CD-ROM, FDDI. RAID quantities are USABLE.



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3.4.2.1 Client Subsystem

There is no dedicated hardware support (HWCI) for the Client Subsystem. The Client software configurations are supported by: (1) non-ECS provided hardware platforms, in the case of Client software utilized by the user community, or (2) ECS provided workstations utilizing Client software in support of operations users (network management, DAAC operations, etc.).

3.4.2.2 Data Server Subsystem

During the Release B time frame at the JPL DAAC, a Data Server configuration is supplied to support the following data storage and access services: ALT RADAR instruments and data as described in the February 1996 Technical Baseline, as well as any identified V0 migration data. The configuration discussed in the subsections that follow provides a snapshot view of the configuration and sizing of the Data Server hardware for Release B. Sizing refinements as compared to the IDR document are based on project level decisions in the areas of reprocessing, backup, user pull sizing, produce versus store policies, and adjustments to the technical baseline driven by processing modifications by the instrument teams. The reader is encouraged to refer to the Data Server specific volume of DID 305 for more details on the operational and engineering concepts that form the basis for the DSS Release B design and a more detailed discussion of these design variables.

The Data Server configuration has made some assumptions in the area of reprocessing in regards to disk, robotics, tape drives, and general I/O. The dynamic model used for sizing produced peak and average usage statistics for Data Server resources, monitored and calculated over the full processing cycles of the Release B products (i.e., daily, weekly, monthly, etc.). The approximate ratio between the average and peak resource usage for the Data Server configuration is 1:2. The peaks are caused by different data staging requirements of specific PGEs. The Processing Subsystem's disk usage patterns are consistent with this pattern. Therefore, Data Server archive hardware components' sizing to two times the average computed requirements will be sufficient to keep up with the overall level of demand. Reprocessing load, estimated to be equal to one time the processing load, can be worked off in the off-peak processing times, as shown by the analysis done after IDR B. An expansion to the two times reprocessing load can be achieved by horizontal scaling of the components, i.e. adding additional quantities of hardware to the existing configuration.

The Data Server Subsystem hardware configuration consists of five hardware CIs and is sized for the mission support as described above for a period of one calendar year beyond AM-1 launch date (Epoch k of the Technical Baseline) plus V0 data migration for the same time period:

- *Access Control & Management (ACMHW HWCI)* -- The access hardware allows for client access (both the client subsystem and direct "push/pull" user access) to the Data Server subsystem, provides tools and capabilities for system administration, and is broken down into two components; Administration Stations (AS) which consist typically of operations support workstations, and Access/Process Coordinators (APCs) which consist of server class machines with host attached storage.
- *Working Storage (WKSHW HWCI)* -- Working Storage (WS) hardware of the Data Server supplies storage used for temporary file and buffer storage within the Data Server architecture. For Release B this consists of disk storage only (no archive tape and robotics).

All data in Working Storage regardless of storage duration is considered temporary in nature and not part of the permanent archive.

- *Distribution and Ingest Peripheral Management (DIPHW HWCI)* -- The hardware of the Distribution and Ingest Peripheral Management HWCI supports the hard media distribution methods for data dissemination from the system, as well as hard media ingest of data into the system. The hardware provided by this HWCI includes a variety of media and media drives, jukeboxes/stackers as necessary, and server hosts and disk storage for network distribution.
- *Data Repository (DRPHW HWCI)* -- Data Repositories (DRs) are the hardware components that store and maintain data permanently. This consists of DBMS disk-resident repositories and archive tape library based data repositories. This HWCI provides the disk, server, archive robotics, media and archive tape drives required to support the permanent storage repositories.
- *Document Data Server (DDSHW HWCI)* -- This HWCI provides the disk and server required to support the Document Data Server portion of the DSS.

3.4.2.2.1 Rationale

The following subsystem-wide assumptions were applied in sizing the Data Server hardware components. The Data Server Subsystem is sized for ALT RADAR as described in the February 1996 Technical Baseline, as well as V0 migration data support, for a period of one calendar year beyond AM-1 launch date. A combination of static and dynamic modeling was used to size the permanent data repository components, such as the number of robotic arms, tape drives, and production related staging disk. The ECS technical baseline for February 1996 was used both in dynamic modeling as well as in static analysis. User modeling data was used in dynamic models for estimating the user access rates to the system where appropriate, as well as the pattern of user interaction with the system. However, DSS sizing is still being driven by the ECS Project direction to size for a daily distribution volume two times the site's nominal daily production volume.

ACMHW Analysis was undertaken primarily for the sizing of the APC server hosts and their attached disk storage. The administration workstations are assumed to continue to be minimally configured workstations designed to perform various operations functions (e.g. DBMS administration, repository administration, etc.). Client desktop services as well as X protocol access to Data Server hosts is the driving sizing factor for the workstations.

APC Server -- The APC server provides the session establishment point for the client, routes service requests to the other CSCIs and HWCIs, and functions as the electronic distribution channel for the DSS user pull and push loads, as well as for the DAAC-to-DAAC transfers. The APC server host runs the following software processes and applications: ScienceDataServer Process, ScienceDataServer Administration Process, SubscriptionServer Process, Network ResourceManager Process, PullMonitor Process, CSS DCE client, CSS logging API, and an MSS agent. The following is the CPU allocation (CPU loading for peripheral support is based on SGI configuration guidelines):

0.5 CPU Monitoring/Managing Tasks (estimated)

\+ *2 CPUs Subsetting/Subsampling (Dynamic Modeling)*

\+ *1 CPU Operating System and Applications (estimated)*

\+ *2.3 CPUs for client support (estimated for session threads)*

\+ *0.15 CPU for 2 Differential SCSI -II Interfaces (2 SCSI [disk] at 5 MB/sec - 7.5% of a CPU for each 5 MB/sec; 2 * 5 * 0.075/5)*

\+ *0.002 CPUs for SCSI RAID controller support (1.5% of a CPU for each 5 MB/sec of controller I/O; 0.6*0.015/5)*

\+ *0.009 CPUs for FDDI I/O support (7.5% of a CPU for each 5 MB/sec of I/O: 0.6 MB/sec / 5 MB/sec * 0.075)*

\+ *0.008 CPUs in support of subscriptions.*

This requires a total of 6 equivalent CPUs. The SGI Challenge L server with 6 CPUs and 512 MB of RAM will be selected as the APC server. The server will be equipped with 6 GB of local disk, 2 differential SCSI-II controllers for the local disk pool, 2 SCSI RAID Controllers (see *APC Host Storage* below), and 2 FDDI Interfaces. Failover will be provided by a second identically configured SGI Challenge L. Here and elsewhere at the JPL site all SGI CPUs contain 200 MHz R10000 processors.

APC Host Storage -- The APC server host disk is sized for electronic ingest (almost exclusively from sources external to the DAAC), as well as electronic distribution (again, almost exclusively to the recipients external to the DAAC) since this pool of hosts is designed to manage the requests to the Data Server as well as the service response. APC storage must also be sized to support functions such as subsetting/subsampling and storage of user session context, which keeps track of user session interactions that may be suspended and resumed.

For Release B, the electronic distribution, as defined within the ECS Technical Baseline for CDR, is "one times" the total Data Server ingested volume. This "one times" volume is made up of data that is "pushed" and "pulled" by the user. The distribution of this electronic data is assumed to occur over a 24-hour period. It is further assumed that on the average each granule placed on the distribution volumes are pulled/pushed to two separate users and hence is counted twice in the total daily output. This assumption is based on the workings of subscriptions (assuming that a granule that is subscribed to more than once) and the fact that “interesting” data will be requested more than once when inserted, while some data may not be requested at all.

Distribution of data to users is estimated at 0.25 MB/s (21.6 GB/day), with 0.05 MB/s per assumption of 20% of distribution allowance (45 MB accumulation in 15 minutes disk latency) received from users and other DAACs. While both the I/O capacity and the disk allocations take the DAAC to DAAC transfers (100% electronic) into account, the rate is not a driving factor in the design. Allowing for two days' worth of capacity on a fast access medium, this yields 43.3 GB of RAID another 1 GB is added to save user session context. The total is 45 GB (rounded upward to the nearest GB). Rolled into this disk allocation is the 0.7 GB estimated by Dynamic Modeling to be required to support subsetting functions.

WKSHWWorking storage resources had been assumed at IDR-B to be network attached and largely pooled, allowing sharing of disk resources among servers from the other DSS HWCIs. The technology required to accomplish the pooling of disk resources did not mature as anticipated in some cases, or is only available in a homogeneous vendor solution and is prohibitively expensive in others. Therefore, the Working Storage RAID for short-term storage will be host-attached. The host server itself is part of the DRPHW CI. Dynamic modeling has shown, that 15 minutes of working storage will allow the maximum benefit in terms of handling the data flow to and from the processing. No further benefit will be realized by adding a larger amount of storage for a longer term data buffering.

The overall data storage requirement within the WKSHW HWCI is minimal due to the lack of any identified interim products to be stored within working storage at JPL.

The RAID requirement for working storage is approximately 6 GB (rounded upward to the nearest GB).

DIPHWThe DIPHW configuration at JPL includes primarily server host and disk units to serve media based distribution production temporary staging (as well as for some types of Ingest as well), and includes a number of peripheral form factors. Two servers (Sun Ultra) are provided for temporary staging support and peripheral support.

Temporary Staging Server Support -- This server is designed to support the media distribution load (as well as a small factor for ingest loads). It is designed to handle the I/0 for 1x (one times) distribution of the Data Server ingested volume per twenty-four hours of operation, servicing this load in a nominal 8 hr. total shift period. The platform is sized to handle the network transfer traffic to local disk from the FSMS Server Host source, as well as the media preparation and media ingest I/O. The software processes/applications mapped to this server are: DistributionServer process, ResourceManager Processes for CD-ROM, various tape, and printers, CSS DCE client, CSS logging API, and an MSS agent. Two server hosts are provided in order to comply with RMA requirements for the function of archiving and distributing data with the required availability of 0.98 and the mean down time not to exceed 2 hours.

The disk associated with the hard media distribution platform is sized for hard media distribution of 1x (one times) of the total Data Server ingested volume per twenty-four hour operations. The same assumption is used here as was used in the APC disk sizing, namely that on the average each granule placed on the distribution volumes are written twice to two separate users. 24 hours accumulation capacity, plus 15 minutes retention of the volume of the hard media ingest is sized. The total volume of the JPL data backup sent to the GSFC DAAC on hard media is conservatively estimated to be 2% of produced data. The DIPHW disk is sized at 23 GB (rounded upward to the nearest GB).

The servers included in the DIPHW must, in aggregate, support 0.26 MB/s of distribution and approximately 0.05 MB/s of ingest via hard media over each 24 hour period during 7 week days. The distribution and ingest, however, will only occur during the 8 hours of the 5 working days, raising the total outgoing media flow rate to 1 MB/sec.

The CPU allocation for each of the two servers is as follows:

0.5 CPU Monitoring/Managing Tasks (estimated)

\+ 1 CPU Operating System and Applications (estimated)

\+ 0.2 CPU for 4 Differential SCSI -II Interfaces

\+ 0.2 CPUs for Fiber Channel RAID controller support

\+ 0.1 CPUs for FDDI I/O.

This requires a total of 2 equivalent CPUs. The Sun Ultra 4-slot with 6 GB of local disk and 256 MB of RAM is specified for these servers. A total of 12 GB of additional disk will also be allocated to each of the two servers in this HWCI.

Peripheral Support -- The peripherals supported at the JPL site for Release B were selected based on Level Four requirements: S-DSS-30440, S-DSS-30470, S-DSS-30480 (reference SDPS Requirements Specification for the ECS Project, 304-CD-002-002). The peripherals supplied here are included in the configuration to primarily support distribution functions. However, the Ingest Subsystem (Ingest Client) residing at JPL may utilize peripherals to perform some media based ingest, as necessary, based on media form received for storage. This applies only to peripherals not already configured into the Ingest complement for performance reasons.

The types of media form factors/formats selected for Release B include:

- 8mm Tape
- 6250 Tape (heritage)
- CD-ROM
- 3480/3490
- 4 mm Tape
- FAX/scanner

The number of the 8mm and 4 mm tape drives is selected such, that the aggregate I/O bandwidth of each device type will meet the entire bandwidth requirement. The rest of the components will be procured based on the RMA requirements for have adequate spares in the event of a drive malfunction, with the exception of 6250. In the case of 6250, V0 operational experience has shown that its use as a heritage device is low enough to make the provision of a spare drive unnecessary. In the event of the drive failure the low workload will allow waiting for the drive repair or replacement without a noticeable impact on operations. The HWCI complement may be easily scaled for both media types as well as capacity.

This HWCI also provides the network laser printers for the DAAC DS operations.

DRPHW The DRPHW configuration at JPL includes both archive based as well as DBMS based physical repositories. They are sized as follows:

Archive Repository -- The archive component was sized through a combination of both static analysis as well as dynamic simulation. The principal model employed was a static model that utilized as input both equipment performance parameters and data flow estimations that were output from the dynamic model. The equipment performance parameters are vendor specifications derated based on reported user experience. The dynamic system model was based on a discrete event simulation with constrained resources assumed. Modeling runs based on the February 1996 Technical Baseline were performed. The dynamic modeling results were also used as a check of the static model results. Specific data regarding disk, tape drive and robotic resource utilization was obtained from the static model. This data was coupled with the key driving requirements with respect to distribution (e.g. the x2 distribution cap, the User Model service access predictions for epoch k), flow analysis, and data with respect to hardware and software COTS selections.

AMASS was chosen as the Release B archive FSMS. For the FSMS Manager host server, the platform is selected on the basis of FSMS(AMASS)/platform COTS S/W compatibility. Memory and cache estimates are currently based on vendor recommendations, reference "AMASS Archival Management and Storage System, Installation on Silicon Graphics", EMASS Part Number 600149, AMASS Version 4.2.4, March 1995. Aside from the AMASS FSMS the following processes and applications will run on this server: ResourceManager Process for the staging disk, StagedDataMonitor Process, CSS DCE client, CSS logging API, and an MSS agent.

The CPU allocation for this server is as follows:

0.5 CPU Monitoring/Managing Tasks (estimated)

\+ 1 CPU Operating System and Applications (estimated)

\+ 0.02 CPU FSMS Allocation (2.4 MB/sec total flow to and from the ATL *0.8% of a CPU per MB of flow)

\+ 0.4 CPU for 7 Differential SCSI -II (3 SCSI [disk] at 5 MB/sec - 7.5% of a CPU for each 5 MB/sec +4 SCSI [tape] at 5 MB/sec - 0.8 % CPU/ 1 MB/ sec; 3 * 5 * 0.075/5 + 4*5*0.008/1)

\+ 2.3 CPUs for client support (estimated for session threads)

\+ 0.04 CPUs for FDDI I/O support ({total data flow of 2.4 MB/s + control flow of 10%}/5 MB/sec * 0.075).

This requires a total of 4.26 equivalent CPUs. An SGI Challenge L server with 6 CPUs will serve as the DRPHW server. 6 GB of local disk and 512 MB of RAM is also required for the server. A second 4 CPU Challenge L will be used as a backup server. Additional 10 GB of RAID disk are required.

For the Archive Tape Library Robotics an EMASS Automated Management Library system ABBA/E was selected for Release B based on its ability to accommodate multiple media form factors, storage density, growth capacity, floor space utilization, compatibility with COTS software and a number of other factors. This selection process is documented in the SDPS Storage Technology Insertion Plan white paper (June 1995, #420-WP-003-001) and is not fully discussed here. Given data with respect to the robotic device, and assuming the performance signature of 3590 drives in the robotic unit, the analysis resulted in a utilization factor for sizing estimation purposes as given below:

JPL: Configuration: 1 Quadro tower

Calculated Robotics Utilization: 1 Robotic Arm

Calculated Tape Drive Resource Utilization: 5 units

The Release B JPL configuration uses 3590 (NTP) technology, yielding a total robotic storage density of approximately 48 TB The volume calculations are based on the Technical Baseline of February 1996 for the Release B product data volumes and for the identified V0 migration. In epoch k of Release B the accumulated JPL data volume is projected to be approximately 15.5 TBs including 2% backup volume and migration of the currently identified V0 data. Browse data at epoch k cumulates to approximately 442 GB and is part of the permanent archive, bringing the total to 15.94 TB. It is assumed that the product data accumulates over the September 1997 through June 1999 time period, epoch k. No compression is assumed. Addition of a spare tape capacity of 10% brings the total media count to 17.54 TB, 1,754 of 3590 tape cartridges.

DBMS Repository -- The Data Base Management System (DBMS) Repository component was sized as follows based on static data size analysis as well as transaction based analysis. The transaction analysis is based on both "push" (production metadata update) and "pull" (user access and distribution) loads. Transaction rate was modeled based on the user service request rates as described at PDR time in the User Pull Analysis Notebook, 160-TP-004-001, Question 47 and a cross section of query types derived from the DBMS Benchmark Report, 430-TP-003-001.

The DBMS Server Host was sized based on the transaction analysis mentioned above, as well as platform suitability analysis based on the DBMS COTS software selection for Release B Data Servers (Illustra). Platform suitability is based on the DBMS software manufacturer's compatibility recommendations, benchmark data, and project bench marking activities. Aside from the Data Base engine, the following processes will run on this host: CSS DCE client, CSS logging API, and an MSS agent.

DBMS Server Disk was sized based on the *core metadata* associated with ADEOS II and ALT RADAR mission data for the Release B timeframe. This timeframe is from 1997 through 1999. Refer to Table 3.4.2.2-3 for DBMS Repository Sizing beyond the Release B timeframe. Table 3.4.2.2-2 identifies the Release B datasets used for the sizing.

Table 3.4.2.2-2. Release B Datasets Held by the Data Server Subsystem

Product	Instrument	Product Description	Platform
ADEOS-SWS-L0	ADEOS	Processing Data Stream from ADEOS Grd. System	
SWS-L0-L1B	SeaWinds	Level 0 Processing Data to Level 1B Data	
SWS-AMSR L1_Rev	SeaWinds	Processing Level 1 AMSR to Rev. Based Lev 1	
SWS-L1B-L2	SeaWinds	Level 2A&B Processing of Level 1B	
DFA-RAW2STR	DFA	Produce DFA-STR Level 0 S/C Telemetry Record	ALT RADAR
DFA-STR2SDR	DFA	Produce DFA-SDR Level 1B Data	ALT RADAR
DFA-TIDES	DFA	Produce DFA05 TidesData	ALT RADAR
DFA-SDR2IGDR	DFA	Produce DFA-IGDR Level 2a Data	ALT RADAR
DFA-IGDR2GDR	DFA	Produce DFA-IGDR Level 2b Data	ALT RADAR
DFA-Level_3_MAP	DFA	Produce Level 3 Sea Surface Topo Map	ALT RADAR
MR-RAW2SDR	MR	Produce MR-SDR Level1B Data	ALT RADAR
MR-RAW2SDRCorr	MR	Produce Corrected MR-Sensor Level1B Data	ALT RADAR
DFA-ICE_SHEETS	DFA	Produce Level 3 Map Ice Sheet Elevation Maps	ALT RADAR

<u>The key assumptions associated with the DBMS repository sizing are as follows:</u>

- o The products lists have been derived from the DAAC instrument teams representatives, the ECS Technical Baseline and in coordination with Science Metadata sizing for the SDSRV DBMS DRPHW CI.
- o The period of data capture for Release A products on the TRMM mission is 8/17/97 to 12/31/98.
- o The period of data capture for Release B is 1/1/1997 through 12/31/1999.
- o All products are assumed to conform to the Proposed ECS Core Metadata Standard v2.0, 420-TP-001-005, Dec. 1994.
- o The metadata sizing has been calculated from the Metadata Expected with each granule table on Page 94 in the Proposed ECS Core Metadata Standard v2.0, 420-TP-001-005, Dec. 1994.
  - The calculated size of 1.823 KB per granule has been obtained from this data source.
- o An overhead factor of 2.36 for implementation in Illustra has been estimated based on the benchmarking activities as outlined in the DBMS Benchmark Report, 430-TP-003-001. This assumes a high level of query / insertion activity and a low level of update / deletion activity.
- o An estimated overhead of 80 MB will be made for the Illustra product code. Note that this includes sizing for the Illustra database product, the 2-D Spatial Data Blade, and the 3-D Spatial Data Blade.
- o All instruments on TRMM are considered to exist in the Data Server as a continuation of Release A.
- o All instruments on AM-1 were included in the product lists.

- o Keyword metadata per document is derived from Release A, phase2 DDSRV. Average size is 1727 bytes.
- o Sizing for document metadata and storage is assumed during initial Release B operations because time phasing of document production is indeterminate.
- o Sizing includes requirements for a RAID 5 overhead factor of 1.125.

Table 3.4.2.2-3. JPL DBMS Repository Sizing (GB)

DAAC	1997	1998	1999	2000	2001	2002	EOC
JPL	0	0.2	0.6	0.9	1.3	1.6	1.9

The calculated disk capacity for the JPL repository (static analysis) results in a computed requirement of .6 GB. Due to the operational experience with the user space requirements, at least 5 GB of disk space must be allocated for a high use data base functioning. Therefore, at least 5 GB beyond the calculated storage requirement will be allocated - 5.6 GB. (The closest available quantity of disk equal or exceeding 5.6 GB will be purchased.) Dual host configuration will allow for failover. Host type will be a SGI XL class machine.

DOCUMENT DATA SERVER Document handling is handled via a dedicated Data Server implementation, geared to the predicted document ingest and access volumes and the nature of the COTS S/W requirements imposed on the support hardware. The Document Data Server is provided as a simple server configuration with network access. The following assumptions were made in the preparation of the JPL Document Data Server configuration:

1. Documents and document metadata together have been considered as a basis for the sizing calculations.
2. Totals for MSFC are included in the GSFC totals.
3. Document related data includes: 5 guide document types, algorithm descriptions, production plans and reference papers. These from the DDSRV Detailed Design for ESDTs (DID 305).
4. Guide document sizes (5 guides) from Release A, phase 2 of DDSRV are sized at 1.5 MegaBytes each.
5. Production plans are assumed to be on per DAAC, sized at 1.0 MegaBytes each.
6. Reference papers are sized at 6.5 MegaBytes each; one per instrument per platform.
7. As a typical example of other documents, the CERES ATBD and LaRC Handbook file sizes were used as the size of ALGORITHM DOCUMENTATION for each TRMM instrument. One ATBD is assumed per instrument.
8. The creation of an ATDB is dependent on the establishment of a new dataset. Therefore, the accumulation of individual granules has no effect on the growth in the number of ATDBs.
9. Sizing includes requirements for a RAID 5 overhead factor of 1.125.
10. The figures are approximations, which will be refined over time. The Document Data Server architecture is scaleable.

11. The Document Data Server continues to exist as a separate server. As the design effort for Release B continues relative to the Sybase/Illustra selection, the Document Data Server could be collapsed into the DBMS Server. This would change the document storage sizing and cause it to be added into the DBMS Server sizing.
12. The entire document Data Server DBMS sizing is assumed to be available at the beginning of the Release B timeframe. This is to allow sufficient capacity to be available to handle both historical document conversion and new document requirements. This includes the maximum required by the end of Release B.

A 2 CPU SMP server was selected based upon operational experience with the EDF EDHS. A WAIS-like, full text indexer, an http server, and additional custom developed software will reside on this host. The following processes/applications run on this host: Document Data Server Process, WWW Server Process, Document Repository Process, Client Applications Process, CSS DCE client, CSS logging API, and an MSS agent.

The disk complement was sized to hold the document metadata for the data product collections associated with the ADEOS II and ALT RADAR mission. Sizing for document metadata was based on available V0 guide document sizing, and the 2.0 Core metadata baseline. The calculated required disk capacity for all document collection alone is 2.5 GB.

3.4.2.2.2 Configuration

The specific sizing for the Release B JPL Data Servers, derived from the rationale described above, is synopsized below. Figures (EDS provided figures) provide the a preliminary design for the site's configuration. Additional details on specific component configurations and sizing are provided within the figures.

For the JPL Data Server:

ACMHW

- Admin. Workstations: 2 ea. of SUN Ultra
- APC Hosts: two 6 CPU SGI Challenge Ls, configured with 6 GB of local disk and 45 GB of RAID

WKSHW

- 6 GB of RAID

DIPHW

- Staging Server Host: two SUN Ultra 4-slot, with 6 GB each local disk and 23 GB additional RAID disk
- Standard Release B Peripheral Set: 8mm Tape drives and stackers, 4mm Tape drives and stackers, 6250 Drive, CD-ROM drive and jukebox, FAX/scanner, 3480/3490 outboard drives.

DRPHW

- FSMS Server Host: 6 CPU SGI Challenge L, with 6 GB local disk, 512 MB RAM, 4 CPU SGI Challenge L, 6 GB local disk, 256 MB RAM, and additional 10 GB of RAID
- Archive Tape Library Robotics: 1 EMASS AML/E: 1 robotic arm, 1 Quadro tower

- Tape Drives: 5 3590 drives
- Tape Media: 1,709 of 3590 tape cartridges (10 GB each)
- DBMS Server: two of 2 CPU SGI Challenge XL, with 10 GB of shared disk

DDSHW

- WAIS/http Data Server 2 of 2 CPU SMP Server
- Data Server Disk: 6 GB mirrored in two machines for Release-B

3.4.2.3 Data Management Subsystem

The Data Management Subsystem (DMS) consists of a single Hardware CI (HWCI) that will also support the Release B processing requirements of the Interoperability Subsystem (IOS) at the JPL DAAC site.

The DMS is responsible for supporting Advertising Service CI, Data Dictionary CI, Gateway CI, Local Information Manger CI and Distributed Information Manager CI processing activities generated directly from user "pull" search invocations. The DMGHW CI consists of three major components: 1) DBMS/Web Server, 2) Database Management Workstation, 3) Data Specialists and User Support Workstations.

The DBMS/Web server is the primary hardware component in the Data Management Subsystem. The server provides DBMS storage, input/output (I/O), and processing resources in support of the Advertising Service CI, Data Dictionary CI, Gateway CI, Local Information Manager CI and Distributed Information Manager CI in Release B.

The DMGHW CI configuration provided in Section 3.4.2.3.2 depicts the Release B hardware design. The Release B hardware design accommodates Release B platform design issues concerning scalability, RMA and evolvability. The hardware design is tailored to Release B JPL DAAC specific processing needs in support of Advertising Service CI, Data Dictionary CI, Gateway CI, Local Information Manger CI and Distributed Information Manager CI processing functions. The Release B JPL DMGHW CI is designed to support BOREAS, FIFE, OTTER, NPP and other mission datasets. Section 3.4.2.3.1 provides the rationale behind the recommended Release B hardware configuration and is subject to change as Data Management software CI (under investigation in the incremental development track) prototyping results become available.

3.4.2.3.1 Rationale

The performance drivers for sizing the DMGHW CI server for Release B are:

- User Characterization analysis of science and non-science user search invocations
- DBMS/CI transaction rate (performance) analysis
- DBMS/CI prototype/benchmark analysis
- Hardware Scalability / RMA / Evolvability Analysis

User Characterization Analysis: User Characterization data provides the projected number of science and non-science users, frequency of search invocations per time period, and the percentage of invocations for different types of searches to be supported in the Release B time frame. In Release B, it is expected that science users will primarily access the DM services (Gateway CI, Data Dictionary CI, Local Information Manager CI, Distributed Information Manager CI) while the bulk of the accesses to the Interoperability service (Advertising Service CI) will originate from within the non-science community.

It is assumed that non-science users will access the Advertising Service CI 86% of the time, and DM CIs 14% of the time as documented in "User Characterization and Requirements Analysis" (19400312TPW). The number of searches per hour being processed by the DM CIs in response to queries by science users is based on the ECS science user scenarios in which users are assumed to be accessing the system through the client. Because of the increasing popularity and ease of use of the WWW, it is also expected that science users will make use of the Advertising Service at a rate equal to 25% of DM searches. Data provided by the User Characterization Team apply to epoch m (first quarter of 2000) since the data are meant to represent maximum usage loading (this will occur at the end of Release B).

Tables 3.4.2.3-1 and 3.4.2.3-2 summarize the number of science user system accesses per day and the fraction of invocations per search type for DM services as documented by the User Characterization Team. Table 3.4.2.3-3 summarizes the total number of searches per hour for the busiest hour of the day.

Table 3.4.2.3-1. JPL User System Accesses per Day for Science Users (Epoch m)

DAAC	User System Accesses per Day
JPL	176

Table 3.4.2.3-2. JPL Science User Search Types for Gateway CI service (Epoch m)

Search Type	Fraction of total invocations
Simple Search/1 site	.263
Simple Search/multi-site	.279
Match-up Search/1 site	.272
Match-up Search/multi-site	.185
Coincident Search/1 site	0.0
Coincident Search/multi-site	.000374

Table 3.4.2.3-3. JPL Searches per hour for Science Users (Epoch m)

DAAC	Searches per hour (busiest time of day)
JPL	7

The data for searches submitted by science users is categorized into six different types (simple/1, simple/multi, match-up/1, match-up/multi, coincidence/1, and coincidence/multi) for DM services; however, there are only three types of searches for the non-science user data. Each of the three search types that exist in the non-science user data was subdivided into one-site vs. multi-site by applying the proportions of one-site vs. multi-site that exist for science users to the non-science user data. For example, the relative proportions of simple search/1 site and simple search/multi-site for science users is 0.263 and 0.279, respectively. The number of simple searches submitted by non-science users was divided into one-site and multi-site using these same proportions. Only one search type (simple/1) pertains to the Advertising Service CI.

Tables 3.4.2.3-4 and 3.4.2.3-5 summarize the number of non-science user system accesses per day and the fraction of search invocations for DM services as documented by the User Characterization Team.

Table 3.4.2.3-4. JPL User System Accesses per Day for Non-Science Users (Epoch m)

DAAC	User System Accesses per Day
JPL	2012

Table 3.4.2.3-5. JPL Non-Science User Search Types for Gateway CI service (Epoch m)

Search Type	Fraction of total invocations
Simple Search/1 site	.31
Simple Search/multi-site	.29
Match-up Search/1 site	.09
Match-up Search/multi-site	.06
Coincident Search/1 site	0.0
Coincident Search/multi-site	.25

DBMS Transaction Rate Analysis: In order to size the DBMS server it is necessary to estimate the size of the Interoperability (Advertising Service CI) and Data Management (Gateway CI, DDICT CI, LIMGR CI, DIMGR CI) services and then determine the transaction rates, or database throughput that must be provided in support of the "pull" search activities that will be invoked by the user community. The transaction rate analysis is based on assumptions regarding the amount of processing associated with the different types of search requests that pertain to the Interoperability and Data Management software CIs. Release B transaction assumptions were made to define a transaction loading value per search request. Number and type of search request are provided by the User Characterization Team. Depicted transaction loading values are assumptions that are based on search complexity. The loading values for search requests will be refined with actual performance benchmarks as future prototypes are completed. The observed transaction loading from future prototyping/benchmarking activities will be compared to the predicted ones (documented below) and the sizing analysis will be updated as a result (these transaction loading assumptions are defined as "nominal" cases). The transaction data provided is projected for the Release B time-frame.

The processing (transactions per search invocation) assumptions are based on preliminary transaction analysis results for the Advertising Service and DM CIs and will be revised based on future prototyping/benchmarking results as they become available. Tables 3.4.2.3-6 and 2.4.2.3-7 list the predicted transaction load associated with the Gateway CI and Advertising Service CI based on frequency of science user search invocations. Searches/hour are calculated for the busiest time of day at the JPL DAAC site.

Table 3.4.2.3-6. JPL Science User Transaction Analysis for Gateway CI service (Epoch m)

Search Type	Percentage Invoked	Searches/hour	Processing Assumptions (Transactions per Search Type)	Transactions /hour
Simple Search/1 Site	26.3	2	5	10
Simple Search/Multi-Site	27.9	2	10	20
Match-up Search/1 Site	27.2	2	5	10
Match-up Search/Multi-Site	18.5	1	10	10
Coincident Search/1 Site	0.0	0	5	0
Coincident Search/Multi-Site	.0374	.002	25	.05

Table 3.4.2.3-7. JPL Science User Transaction Analysis for Advertising Service CI (Epoch m)

Search Type	Percentage Invoked	Searches/hour	Processing Assumptions (Transactions per Search Type)	Transactions /hour
Simple Search/1 Site	100	2	5	10

Tables 3.4.2.3-8 and 3.4.2.3-9 list the transaction analysis for the Gateway CI and Advertising Service CI based on daily non-science user accesses as depicted in "User Characterization and Requirements Analysis" (19400312TPW). The estimated total non-science user system accesses per day for the Gateway CI and the Advertising Service CI is estimated to be 2012. The percentage that each search type, pertaining to the Gateway CI and Advertising Service CI, is invoked is also taken from the same document. Tables 3.4.2.3-8 and 3.4.2.3-9 are completed with the assumption that there will be at least ten search invocations per non-science user access on average.

Table 3.4.2.3-8. JPL Non-Science User Transaction Analysis for Gateway CI Service (Epoch m)

Search Type	Percentage Invoked	Searches/hour	Processing Assumptions (Transactions per Search Type)	Transactions /hour
Simple Search/1 Site	31	36	5	180
Simple Search/Multi-Site	29	34	10	340
Match-up Search/1 Site	09	11	5	55
Match-up Search/Multi-Site	06	7	10	70
Coincident Search/1 Site	0.0	0	5	0
Coincident Search/Multi-Site	25	29	25	725

Table 3.4.2.3-9. JPL Non-Science User Transaction Analysis for Advertising Service CI (Epoch m)

Search Type	Percentage Invoked	Searches/hour	Processing Assumptions (Transactions per Search Type)	Transactions/hour
Simple Search/1 Site	100	721	5	3605

Preliminary transaction analysis results for Interoperability and Data Management CI processes are depicted in Table 3.4.2.3-10. At this time the Data Dictionary CI transaction analysis is equated to the transaction analysis of the Advertising Service CI since the type and frequency of transactions are predicted to be very similar. Due to the fact that DIMGR and LIMGR CI processes are perceived as being the most expensive (in terms of cost to the CPU), and that prototypes will not be developed until after Release B CDR, preliminary sizing estimates have been achieved by doubling the transaction load of the Gateway CI and applying the result to LIMGR CI and DIMGR CI processes. Although equating Advertising Service CI and Data Dictionary CI processes, and doubling the Gateway CI transaction load to produce LIMGR CI and DIMGR CI transaction loading does not pin-point the performance cost that will be levied on the DMGHW CI, it does provide preliminary, expected CPU activity in the absence of real-time prototyping/benchmarking results. The preliminary transaction results for the Advertising Service CI, Gateway CI, Data Dictionary CI, LIMGR CI and DIMGR CI will be revised based on future prototyping/ benchmarking analysis results as the Incremental Track software design matures.

Table 3.4.2.3-10 summarizes the science, and non-science user transaction loading per hour for the Advertising Service CI , Gateway CI, Data Dictionary CI, LIMGR CI and DIMGR CI services.

Table 3.4.2.3-10. DBMS Transaction Analysis Summary (Epoch m)

DAAC	User Type	Service	Searches/hour	Transactions /hour	TPM
JPL	Science	Gateway	7	50	1
JPL	Science	Advertising	2	10	.2
JPL	Science	Data Dictionary	2	10	.2
JPL	Science	LIMGR	14	100	2
JPL	Science	DIMGR	14	100	2
JPL	Non-Science	Gateway	117	1370	23
JPL	Non-Science	Advertising	721	3605	60
JPL	Non-Science	Data Dictionary	721	3605	60
JPL	Non-Science	LIMGR	234	2740	46
JPL	Non-Science	DIMGR	234	2740	46
Totals:			2066	14330	240

A sensitivity analysis has been performed with larger loading allocations; the results are depicted below in Table 3.4.2.3-11.

Table 3.4.2.3-11. DBMS Transaction Sensitivity Analysis Results (Epoch m) (loading has been doubled for both search invocations and transaction rates)

DAAC	User Type	Service	Searches/hour	Transactions /hour	TPM
JPL	Science	Gateway	14	200	3
JPL	Science	Advertising	4	40	1
JPL	Science	Data Dictionary	4	40	1
JPL	Science	LIMGR	28	400	7
JPL	Science	DIMGR	28	400	7
JPL	Non-Science	Gateway	234	5480	91
JPL	Non-Science	Advertising	1442	14420	240
JPL	Non-Science	Data Dictionary	1442	14420	240
JPL	Non-Science	LIMGR	468	10960	183
JPL	Non-Science	DIMGR	468	10960	183
Totals:			4132	57320	956

Future Incremental Track Development prototyping/benchmarking activities will provide a more detailed performance analysis of Advertising Service CI, Gateway CI, Data Dictionary CI, Local Information Manager CI and Distributed Information Manager CI processes; therefore, performance transaction analyses will be revised accordingly.

DBMS Prototyping/Benchmarking Analysis: Currently, preliminary Incremental Track Development performance data is being used to size the processing capacity of the DMGHW CI DBMS/Web server. Performance analysis results will be revised as planned prototyping/ benchmarking activities are completed. Major prototyping activities that will affect performance estimates for the DMGHW CI include, but are not limited to: 1) Prototype workshop 2 (Feb 96) 2) EP7 prototype (July 96).

DBMS performance estimates provided in "DBMS Benchmark Report" technical paper (430-TP-003-001), show that for multi-user (32 users) queries (20 similar queries accessing different parts of the test database) running concurrently, the test-bed platform’s CPU became saturated (SUN SPARCstation 20/50). A vendor supplied TPM benchmark for the selected platform (HP K400) for Release B operations is shown in Table 3.4.2.3-12. As a rule vendor supplied Transaction Per Second/Minute (TPS/TPM) ratings tend to be a maximum, or high-end value and do not take into account processing overhead associated with other system processes. Processes that will run on the DMGHW CI in Release B include DCE client, MSS agent, HTTP server, Sybase SQL Server, Sybase Replication Server, Sybase Backup Server, Operating System Services, Advertising Service Server, Gateway Server, Data Dictionary Server, LIMGR Server and DIMGR Server.

Table 3.4.2.3-12. Vendor Platform Performance Estimates

Platform	TPM	MIPS
HP K400 (SMP) with 1 processor (PA 7200 CPU)	1000	146

Disk Capacity Sizing: Disk storage for the DMGHW CI has been determined for each DAAC site based on preliminary Interoperability and Data Management CI DBMS application sizing estimates plus vendor inputs for the following COTS software: 1) DBMS software, 2) Development software, 3) HTTP server software, 4) Operating System software, 5) Communications and Utilities software. Capacity sizing for the Interoperability and Data Management databases was achieved by multiplying the expected byte size for core and collection specific attribute definitions by the total number of core and collection specific attributes. Temporary workspace has also been allocated for Interoperability CI and Data Management CI services dependent on frequency and variation of queries. For example, the DIMGR service has a larger capacity requirement than the Data Dictionary service because it requires more temporary workspace since it handles a greater number and more varied types of queries. The expected capacity of Interoperability CI, Data Management CI, COTS, Operating System and Communications and Utilities software to be installed on the DMGHW CI at the Release B JPL DAAC site is depicted in Table 3.4.2.3-13.

Table 3.4.2.3-13 is filled with preliminary disk sizing results for Release B Interoperability and Data Management software CIs, operational databases and COTS software packages that will be installed on the DMGHW CI at the JPL DAAC site. Some of the results are estimates (such as database sizes) since the DBMS design will mature and impact disk capacity sizing as the Advertising Service CI, Gateway CI, Data Dictionary CI, Local Information Manager CI, and Distributed Information Manager CI under-go future evaluation and prototyping.

Table 3.4.2.3-13. DMGHW CI Disk Capacity Requirements

S/W Component	Release B Capacity
COTS Software:	
Sybase System	300 MB
HTTP Server	10 MB
	Total: 310 MB
Databases:	
Sybase Master Database	3 MB
Sybase Tempdb Database	100 MB
Sybase Model Database	2 MB
Advertising Database	150 MB (Estimate)
Advertising DB Workspace	150 MB (Estimate)
Advertising DB Log	100 MB (Estimate)
Advertising HTML Files	100 MB (Estimate)
Data Dictionary Database	400 MB (Estimate)
Data Dictionary DB log	100 MB (Estimate)
DMS Working Store Database	500 MB (Estimate)
DMS Working Store DB log	100 MB (Estimate)
	Total: 1705 MB
Operating System & Utilities:	
Operating System Software	700 MB
Utilities	200 MB (Estimate)
DCE Client	46 MB
	Total: 946 MB
	Total: 2961 MB

3.4.2.3.2 Configuration

The selected DMGHW CI DBMS/Web server to be implemented in Release B is a low-end SMP server (HP K400) that is scaleable from one to four processors. A single physical DBMS/Web server will be implemented at the Release B JPL DAAC site. At this time a two CPU configuration has been determined to be appropriate for the DMGHW CI DBMS/Web server due to RMA requirements. The Release B HP K400 single server configuration will offer redundancy in the form of: 1) dual processors, 2) dual power supply units, 3) dual FWD SCSI-2 cards, and 4) dual FDDI network cards 5) duplicate OS boot/application disk. The components listed above are hot swap-able units which allow them to be replaced without shutting down the server. Also, the HP-UX operating system features memory page de-allocation which automatically blocks out any portion of memory in which an error has been detected; therefore, a failure to memory will not bring operations to a halt. The single server host configuration will allow applications to be run in parallel across both processors, which enhances load balancing and availability/recovery capabilities. The DMGHW CI DBMS/Web server will automatically reconfigure itself in a single CPU configuration in the event of failure to a single CPU. The dual power supply units, FWD SCSI-2 cards and FDDI network cards will also provide continued availability in the case of failure to a single component (per function). The redundant configuration of the DMGHW CI DBMS/ Web server has been analyzed by the ECS Reliability Engineering Group using COTS vendor provided data to ensure that all functional availability requirements are met. Preliminary analysis results revealed that the DMGHW CI DBMS/Web server has an MTBF (mean-time-between-failures) of greater than 20,000 hours which meets all pertinent RMA requirements.

A RAID disk unit will be attached via FWD SCSI-2 (dual ported) to the DMGHW CI DBMS/Web server (see Figure 3.4.2-2). The RAID disk until will provide operational and mirrored sets of disk devices to the DMGHW CI server in order to provide uninterrupted data availability in the event of a disk failure. The RAID disk configuration will also be implemented such that a failure to a single disk will be recoverable via a "hot-swap" disk capability. The RAID disk until will be comprised of ten disks: five operational and five mirror disks. Each disk contained in the RAID unit will provide a capacity of 2.1GB.

Since the Release B processing requirements for the Local Information Manager CI and Distributed Information Manager CI are largely unknown at this time, the flexibility of the recommended hardware design assures minimum risk. The design allows for 100% growth in both processing and storage capacity in support of the Advertising Service, Gateway, Data Dictionary, Local Information Manager and Distributed Information Manager CIs in Release B.

The following configuration diagram, Figure 3.4.2-2, depicts the recommended server host / RAID disk unit configuration:

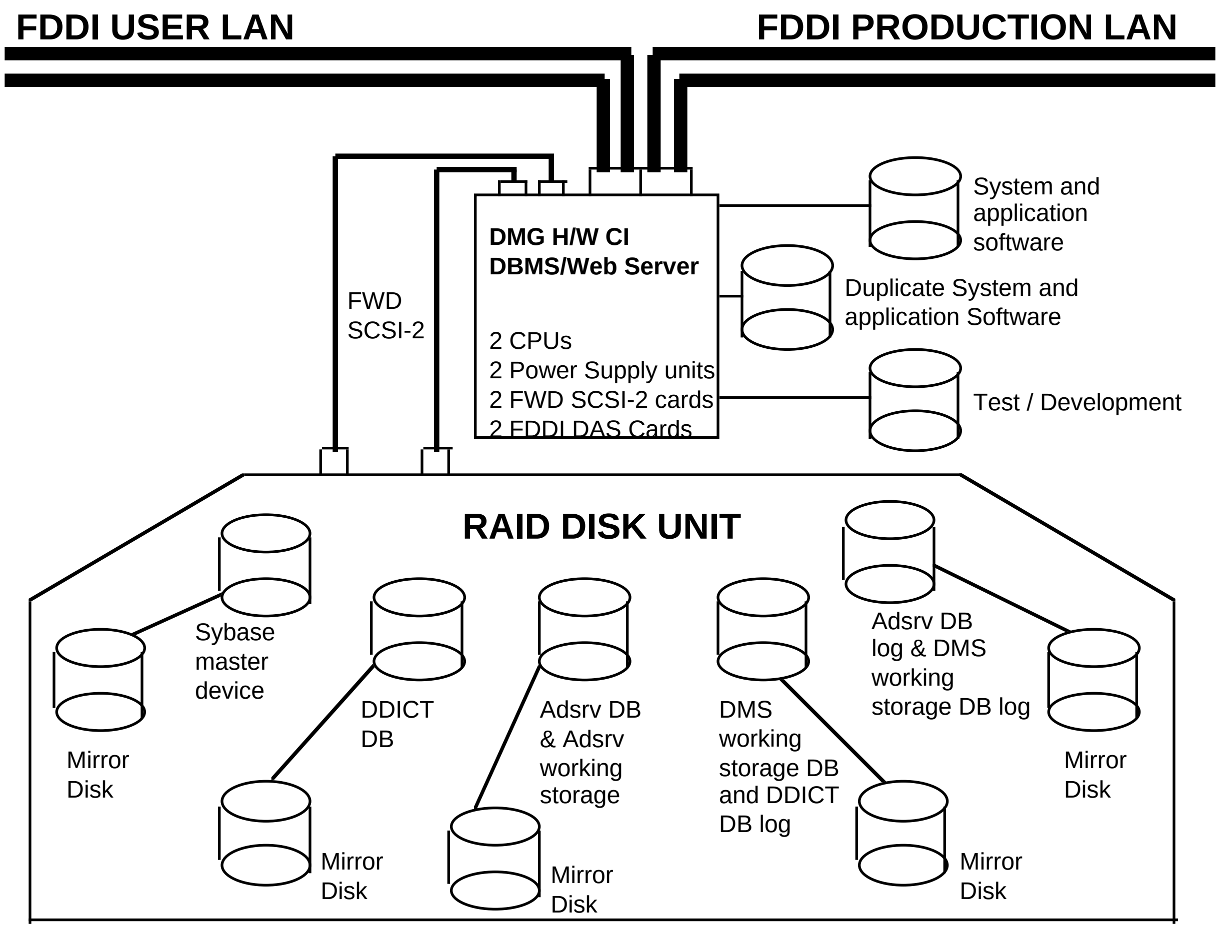

Figure 3.4.2-2. DMGHW CI RAID Disk Configuration

Although the estimates for Advertising Service and Data Management operational databases, COTS software, and operating system and utilities sizing are relatively small, the total disk volume for the DMGHW CI server has been increased in support of Sybase swap (workspace) area, 100% growth capacity for the core operational software, and mirror disk units. The Data Management databases will be replicated (using Sybase replication server) at each DAAC site. The Interoperability and Data Management software CIs will be distributed over multiple disk drives contained in the RAID disk unit in order to enhance performance (vendor and developer recommended); therefore, the total disk volume is well above the actual capacity needed to support the software alone. Additional disk capacity (internal to the server) in the form of a redundant system/application disk, and a test/development disk have also been added to the configuration in support of RMA, and integration and test requirements.

A single 8mm tape drive unit will be configured on the DMGHW CI server in Release B. The 8mm tape drives will be used to backup Advertising Service and Data Management CIs/databases, as well as perform DBA and routine maintenance operations.

A low-end DBMS/DBA uniprocessor workstation will be used for database/system administration activities. A single 8mm tape drive unit will be configured on the DBMS/DBA workstation in Release B. The 8mm tape drive will perform backup/recovery and routine maintenance operations in support of the DMGHW CI DBMS/Web host servers. A small pool of low-end uniprocessor workstations will support Data Specialist/User Support operations. At a minimum the DBMS/DBA and Data Specialist/User Support workstations will be configured with six gigabytes of local disk each. Workstation disk capacities were sized based on IR-1 workstation installation results which included recommendations for additional space per workstation to accommodate the following: 1) User/Temp workspace, 2) Personal development space, 3) Testing, 4) Software upgrades, 5) Working with large files/datasets, and 6) future growth/flexibility. Exact capacities for disk drives are dependent on the procurement process as the type, and size of disks being offered for workstation platforms may fluctuate.

Table 3.4.2.3-14 summarizes the recommended DMGHW CI processing configuration for implementation at the Release B JPL DAAC.

NOTE: The HP K400 SMP depicted in table 3.4.2.3-14 is a low-end SMP class server that is scaleable from 1-4 CPUs.

Table 3.4.2.3-14. JPL DAAC Hardware Configuration

Component	Class/Type	Platform	Qty.	Number of Processors	Memory	Disk Capacity
DBMS/Web Server	SMP	HP K400	1	2	512 MB	27.3 GB
DBA Workstation	Uniprocessor	HP C100/64	1	1	64 MB	6 GB
Data Specialist and User Support Workstations	Uniprocessor	SUN UltraSparc 140	2	1 (each)	64 MB (each)	6 GB (each)

<u>DBMS/Web Server Platform Technical Specifications:</u>

Make: Hewlett Packard
Model: K400 (Low-End SMP class server)
CPU: PA7200 (upgradeable to future PA800 processor)
Clock Frequency: 100 MHz
Number of processors: 1 to 4
MIPS: 146 (1 processor)
TPM: 1000 (1 processor) 3160 (4 processors)
SPECint92: 136 (1 processor)
SPECfp92: 215 (1 processor)
Memory: Expandable to 2GB RAM
Internal Processor-Memory bus bandwidth: 960 MB/sec (peak)
I/O Bandwidth: 128 MB/sec (peak)

3.4.2.4 Ingest Subsystem

Ingest subsystem hardware at JPL is responsible for the ingest, preprocessing, and storage of ALT RADAR DFA and MR and ADEOS II SWS Level 0 data products. Ingest subsystem hardware will also be involved in the migration of existing Version 0 data into ECS Release B. Subsystem configuration and specific component sizing rationale are provided in the following paragraphs.

3.4.2.4.1 Rationale

The sizing of Ingest Subsystem hardware both from a system level and a component level is based on the February 7, 1996, version of the ECS Technical Baseline. Among the information included in the baseline is:

- o data by instrument,
- o average daily data volume by level,
- o and data destination.

Table 3.4.2.4-1 provides a synopsis of the Ingest data volumes required for Release B at JPL.

Table 3.4.2.4-1. JPL Ingest Data Volumes - Release B

Release A DAAC	Daily L0 Volume (GB/day)	Annual L0 Volume (GB/year)	Version 0 Data Migration Volume (GB)
JPL	0.27	98.6	2770

The average expected daily and annual data volumes at each site were calculated from this information and used to determine the required ingest hardware capabilities. Ingest client hosts are sized to accommodate the required ingest volumes as well as I/O and CPU capabilities to support internal data transfers associated with metadata validation and extraction and transfer of data to the Data Server or Processing Subsystems. Working storage disks are sized to accommodate the above functions, as well as provide contingency space for the transfer of more than one days worth of data within a 24-hour period. Since high RMA is a driver for the Ingest Subsystem, all critical components also include some type of sparing or redundancy to ensure that availability requirements are met. The JPL configuration for Release B is sized for the storage of DFA, MR, and SWS Level 0 data for one year of operations.

Queuing Analysis Model An Ingest Queuing Model (Imodel) was developed to assist in the sizing of Ingest Subsystem components for the Release B JPL configuration. This analysis was dependent on a series of model input parameters such as:

- data to be ingested,
- data to be processed,
- data to be stored,
- network component capabilities ,
- Ingest Subsystem component capabilities (e.g. CPU, I/O, disk I/O, operations per byte).

Data flow sensitivity analysis was conducted with respect to changes in data flows and system architecture (parameters). The load presented by each flow in packets per second is a function of the number of bits per second input from the previous process and the mean size of data set that this process expects. Server host read and write operations have associated transfer rate and access time estimates for each data transfer. Conservative estimates of 2 MB/sec are used based on results from Data Server prototyping efforts. Writing of data to the L0 archive repository archive involves the capabilities of the working storage disks, server I/O, and archive repository devices. Finally, the number of copies of data read from the archive and sent to a data sink (e.g., Processing Subsystem) may be varied to determine the additional load of reprocessing on Ingest Subsystem resources.

3.4.2.4.2 Configuration

Brief descriptions of the generic components, provided within the JPL configuration at Release B are provided in Table 3.4.2.4-2. The results of the system design analysis as well at the modeling discussed in Section 3.4.2.4.1, results in a recommended configuration consisting of low to mid-level Symmetric Multi-Processing (SMP) 32-bit machines, capable of supporting multiple network (FDDI and/or HiPPI) and direct-connect (SCSI II) devices.

Working storage devices are RAID 5 units with a minimum of two days worth of space allocated to ingest working storage required to support the functions of acquiring, processing, validation, and archiving L0 data. This volume of working storage allows for one days worth of L0 data to be staged for processing, an additional days worth available for subsequent ingest, and an additional 25% available to service additional Ingest Subsystem needs (e.g., retrieval support, pre-processing, quality checking). Additional magnetic disk resources are supplied within the Ingest Subsystem to support items such as:

- o client host operating system
- o application software and L0 archive database directory information

Table 3.4.2.4-2. JPL Ingest Component Configuration - Release B

Component Name	Class/Type	Comments
Client Host	SMP Server W/S / Server W/S	Single or multi-processor workstation-based servers, up to mid-level SMP servers.
Working Storage	RAID disk	One or more RAID units, site capacity sized. In Release B, this disk buffer acts as temporary staging as well a longer term storage of L0 data (as applicable) for one year (plus or minus, dependent on data type). RAID 5 is used for random access protocol.
L0 Archive Repository	Archive robotics and tape drives	Single robotics unit with multiple tape drives.

The specific sizing derived from JPL Release B requirements is synopsized within Table 3.4.2.4-3 and is highlighted in Section 3.4.2 within the site configuration overview Figure 3.4.2-1. The site overview figure provides additional details on specific component configurations and sizing. The Ingest Subsystem resources at JPL are sized principally for the operational ingest and storage of DFA, MR, and SWS Level 0 data sets, and to support the migration of data products from Version 0. Additional available system resources will be utilized to support the Version 0 data migration effort as discussed in Section 3.4.2.4.1. Additional system resources are available for contingency.

Table 3.4.2.4-3. JPL Ingest Component Sizing - Release B

Ingest Component	Component Class	Quantity	Comments
Client Host (ICLHW)	SGI Challenge L SMP	2	L0 Ingest Client hosts. Hosts are adapted to ECOM I/F and ESN. Host attached disk. SCSI I/Fs to RAID working storage.
(Working Storage)	RAID Disk (host attached)	2	Host adapted RAID disk arrays. RAID 5. SCSI II adapted & cross strapped to Ingest Client hosts. Functions as working storage for up to one year's worth of Level 0 data.
L0 Archive Repository	Archive robotics	1	Robotics unit sized to store one year's worth of Level 0 data plus an amount for long-term storage of Level 0 data where there is no L1A counterpart.
L0 Archive Repository	Archive tape drives	2	Drives mounted in archive robotics to support writing and retrieval of L0 data.
Client Host (ICLHW)	8 mm tape stacker	2	Support for hard media ingest from Version 0. Note: Version 0 data is stored in the Data Server archive repository.
Client Host (ICLHW)	X-Terminal	1	OPS support for Data Ingest Technician(s).

3.4.2.5 Interoperability Subsystem

For the Release B time frame, the hardware support for the Interoperability Subsystem, particularly the Advertising capabilities are provided by the Data Management HWCI. Please see Section 3.4.2.3 for a complete description of this capability.

3.4.2.6 Production Planning Subsystem

The Release B SDPS Planning Subsystem Design Specification, 305-CD-026-002, Section 5, describes the functionality and architecture of the Planning Subsystem (PLS) Hardware Configuration Item (PLNHW CI). Because of the close coupling of scheduling/queuing functions with planning (i.e., use of the PDPS database), Section 5, also addresses the scheduling/queuing hardware within the Data Processing Subsystem (DPS) Science Processing Hardware Configuration Item (SPRHW CI).

This section describes the sizing of the Planning Subsystem (PLS) Hardware Configuration Item (PLNHW CI) for the JPL DAAC site. Because of the close coupling of scheduling/queuing functions with planning (i.e., use of the PDPS database), this section also addresses the scheduling/queuing hardware within the Data Processing Subsystem (DPS) Science Processing Hardware Configuration Item (SPRHW CI).

The JPL PLNHW CI consists of two Production Planning/Management SMP workstation servers which run the Planning Workbench software and the PDPS database. A Production Planning/Management workstation supports the planning operations staff in performing their routine production planning and management functions. A workstation is provided for operations personnel to access production planning GUIs via the Planning Workbench application. These functions include candidate plan creation, plan activation, entry of production request information and report generation.

The Planning Subsystem is responsible for maintaining the Planning and Data Processing (PDPS) database. This database serves both planning and scheduling. Planning uses the database in support of the Planning Workbench application used for production planning and resource planning activities. Scheduling uses the database in support of the AutoSys application which runs the production schedule.

The JPL scheduling/queuing hardware in the SPRHW CI consists of two Queuing Servers SMP Workstations which run AutoSys and the AutoSys database. Production Monitor Stations run the AutoSys AutoXpert display GUIs.

The scheduling/queuing portion of the DPS is responsible for maintaining the AutoSys database. An active plan is loaded into the AutoSys database from the Planning Subsystem. AutoSys then proceeds to execute this production schedule (the result of activating this plan). AutoSys uses both the PDPS database and its own database during its execution of the production schedule.

Both the PDPS and AutoSys databases are implemented using Sybase. The PDPS database is used for the persistent storage of critical data while the AutoSys database contains the current data for executing a daily production schedule.

3.4.2.6.1 Analysis

Hardware Design Drivers

Drivers for sizing the hardware to support these functions include:

- o database transaction rates,
- o replication of critical data,
- o volume of production status to display,
- o job throughput,
- o the need for a fail-soft science processing architecture.

The primary drivers for sizing the PDPS database are data criticality, support of science processing's fail-soft environment, and the volume of database transactions. The PDPS data is critical because it consists of invaluable PGE information and run-time statistics used for the creation of future plans. The PDPS database supports AutoSys in execution of the production schedule. If the database fails, the launching of production jobs by AutoSys will stop. The PDPS database also needs to support multiple database accesses from both planning and processing.

The primary drivers for sizing the AutoSys database are support of science processing's fail-soft environment, job throughput, and the display of production status. AutoSys launches jobs which stage data, run PGEs, report PGE status, and destage data. If AutoSys fails, no new production jobs will be executed and production will stop. AutoSys must also be able to execute enough jobs (throughput) to process the daily production schedule within the allocated time frame (8 or 24 hours which varies by DAAC). AutoSys' production status also needs to be displayed without saturating the person monitoring production.

Assumptions

The sizing of the planning and scheduling hardware is based on an analysis of the PDPS database transactions and Planning Workbench functions, AutoSys job throughput, and AutoXpert display requirements. The following paragraphs summarize the assumptions used in this analysis.

1. *Technical Baseline* -- The February 1996 technical baseline information was used to derive key parameters that effect the planning and processing workload at each DAAC site. These key parameters include the number of job activations per day for each PGE at each DAAC and the number of PGEs maintained at each DAAC. For example, at JPL during the Release B period (Epoch k, 3Q99), the following parameters were derived:

- No. PGEs at the DAAC	15
- Number of PGE activations per day	176
- Total number of jobs required, including reprocessing of 200%	2,112

2. *OPS Concept* -- These are the operational assumptions.

    a. The production scheduler/planner at each DAAC will prepare and publish a 30 day plan every two weeks. This plan is used to provide some assistance in longer range planning. The 30 day plan is only prepared and published every two weeks - if changes occur after a plan is published, the changes will only be incorporated in the next 30 day plan.

b. The production scheduler/planner at each DAAC will prepare and publish a 10 day plan every week. This plan will provide a finer grain description of planned activities. Like the 30 day plan, this plan will not be replanned and distributed except on the regular weekly boundaries.

c. The production scheduler/planner at each DAAC will prepare and activate a daily plan or schedule once per day. This schedule will be replanned as required during the course of the day.

It needs to be noted in this regard, and as described in more detail in the Planning Subsystem design document, that the manner in which each DAAC operations production scheduler/planner decides to conduct planning and scheduling can vary from DAAC to DAAC. The planning and scheduling tools are sufficiently flexible to support a variety of planning and scheduling strategies. The sizing of the storage and the performance of the server is based upon the assumptions given here. It should also be noted that it is not essential that the operations staff conduct replanning for the active schedule if events arise (e.g., processor failures) that would cause the predictions of the active schedule to depart from reality. Processing will continue regardless since jobs will be released for execution as resources (processors and input data) become available.

3. It was assumed that the reprocessing workload is equal to (1x) the standard processing workload in the Epoch k time frame and that the reprocessing workload is two times (2x) the standard processing workload in the Epoch o time frame (near the end of Release B). The hardware selected for JPL is sized to support 2x reprocessing.

4. Several other parameters were estimated as part of the process of developing a model for the database sizing and processing activity. Some of these parameters and their values are:

- No. of working hours per day	8
- No. of long term (30 day) plans stored	5
- No. of short term plans stored	5
- No. of production requests per PGE	4
- No. of replans (active plans) per day	2

5. *Planning Activities* -- The design for the Planning Subsystem was represented as a collection of several activities or functions (e.g., Subscription Manager, Planning Workbench: Candidate Plan Creation, etc. See Planning Subsystem Design). Functions that were activated only infrequently (e.g., Subscription Submittal) were ignored. The activation frequency of these subsystem activities was then identified, where possible from the February 1996 technical baseline summary (e.g., number of jobs activations per day). Subactivities within these functions were identified and an estimate of the processing load was made based upon the complexity of the activity. These processing load estimates were made in terms of the number of transactions (updates, inserts, and reads) made to the PDPS database. These load estimates were then totaled across the complete set of Planning Subsystem activities for the specified frequency of activation for each DAAC site. The PDPS DBMS server sizing was then estimated by scaling upwards from the base processor size.

PDPS Transaction Rate Analysis

Database transaction rates were modeled for the PDPS database by estimating the number of updates, inserts, and reads made to the database when performing planning and scheduling functions. These functions include:

- o Creating Data Processing Requests to be added to AutoSys database (DPRs),
- o Release of DPR jobs for execution,
- o Updating Data Processing Request Job,
- o Getting DPR Job Status,
- o Data Initialization,
- o Local Data Management,
- o Data Staging,
- o Data Destaging,
- o Initiate PGE execution,
- o Monitor Execution,
- o Execute Post Processing,
- o Plan Creation/Activation,
- o Subscription Notifications, and
- o On-Demand Production Requests.

For each of the activities listed above, the number of average daily transactions (updates, inserts, and reads) made to the PDPS database was estimated based on the number of PGE activations per day. The average daily (8 hour) transaction load at JPL based on 176 PGE activations per day is 449,460 (including Sybase replication). This would require 16 transactions per second (TPS). The peak transaction load is 396,000 worse case to create a 30-day plan. The transaction rate of a Sun 75 MHz 2-CPU 20/712 machine is 305 TPS. It would therefore take approximately 22 minutes to create a 30-day plan containing 778 PGE executions at JPL. A 10 day plan containing 778 PGE executions would take approximately 5 minutes and a 1 day plan would take approximately 2 minutes.

PDPS Database Sizing

The PDPS DBMS server supports the PDPS database that contains all the information central to the functioning of the Planning Subsystem. To size the PDPS DBMS server it was necessary to estimate the number of inserts made into the database in order to determine how quickly and by how much the database would grow each day.

The database classes (tables), associated with the PDPS Transaction Rate Analysis functions above, are:

- o DpPrExecutable,
- o DpPrDataMap,
- o DpPrPGE,
- o PlProductionRequest,

- o PlDpr,
- o PlDataGranule,
- o PlODProdRequest.

The number of inserts made to the database are from the PDPS Transaction Rate Analysis. The number of inserts (additional rows added to the Sybase tables) were then input into a Sybase system procedure called sp_estspace. This procedure returns the estimated megabytes of disk space required to store a particular number of rows for a given class (table) above.

The number of PGE activations for JPL is 176. The disk capacity required to store 90 days worth of PDPS database growth is estimated to be 180 MB.

Planning hardware

The Production Planning Subsystem is made up of two 20/712 Sun SMP workstations. Each workstation is attached to two 6.3 GB Sun SPARCstorage MultiPacks (external disk) via fast wide SCSI controllers. Each 20/712 machine will run the Planning Workbench software and Sybase (the PDPS DBMS). Both machines can use the Planning Workbench, one for Production Planning, the other for Resource Planning. Sybase will run on one machine while Sybase replication is run on the second machine, thus creating a copy of the PDPS database and allowing automatic switch over to the replicated database upon a failure of the primary PDPS database. Sybase replication ensures the integrity of the critical data that the PDPS database contains.

The Sun operating system and applications will reside on disk internal to each of the 20/712 machines. The Sybase log, index, and data files will be on external disks. Two sets of three 2.1 GB external disks will be accessible via 2 fast wide SCSI controller cards for each machine.

Each 20/712 machine can be upgraded to use emerging hyperSPARC technology CPUs running at 150 MHz. Future experience with the Planning Workbench software and the PDPS Database will determine if this extra capacity will be needed.

Each SPARCstorage MultiPack disk can be increased to a maximum of 12 disks for a total of 25.2 GB if required.

AutoXpert Display Sizing

Two pairs of X-terminals (in addition to the two workstation's displays) will be used to show production status by using the AutoSys AutoCons' display and the AutoXpert JobScape GUI. Additional AutoXpert GUIs: TimeScape and HostScape are also available. If an operator wants to view the progress of SWS production, he would modify his view of the entire active queue to display only those jobs associated with SWS. To properly do this requires two displays, one for AutoCons and another for JobScape. The other two pairs of displays can be used to display TimeScape and HostScape for the same instrument's production status or another instrument's production could be viewed or maybe the progress of reprocessing jobs could be displayed. Table 3.4.2.6-1 shows the contribution that each instrument's production (PGE activations) makes on total daily production at JPL. Reprocessing at Epoch k (3Q99) will be approximately 100% of normal production growing to 200% of normal production by the end of Release B.

Table 3.4.2.6-1. Breakdown of Instrument Production at JPL

Instrument	# of instrument PGE activations per day / total # of all PGE activations per day
SWS	65%
DFA/MR	35%

The RAM requirements for each of the AutoXpert and AutoCons GUIs can be calculated using the formula:

20,000 kbytes + (5.5 kbytes x # of jobs loaded) = amount of RAM required.

To open all 4 GUIs when the entire days' processing schedule is loaded would require:

[20,000 kbytes + (5.5 kbytes x 2,112 jobs)] x 4 GUIs = 95 Mbytes of RAM minimum.

The 2,112 jobs is derived by multiplying the number of PGE activations at JPL for a 8 hour day (176) by the number of jobs it takes AutoSys to activate a PGE (4) plus an additional 200% increase in job activations due to reprocessing (x3),

176 PGE activations x 4 jobs per PGE x 3 = 2,112 job activations per day.

AutoSys Database Sizing

The size of the AutoSys Database is dependent upon the number of jobs loaded into AutoSys at one time. The database, when loaded with a test of 20,000 jobs, consumed 6 MB of disk space. This number would vary as a function of the complexity of job dependencies.

The AutoSys events database will also require disk space. The events database saves information (starting and run times, success or failure of job, alarms, etc.) about the job activations launched by AutoSys. Estimates show that an additional 12 MB of disk space would be needed to archive 14 days worth of event information for JPL.

AutoSys Job Throughput Analysis

Experience by other AutoSys customers has indicated that AutoSys can sustain 45 jobs per minute while running on a 75 MHz Sun SPARC 20/712 2-CPU machine. Operating in our high availability configuration reduces performance by approximately 35%. Therefore, AutoSys could execute a sustained 29.25 jobs per minute when operating in its Dual Data Server Mode (high availability option). Therefore, a 2-CPU Sun 20/712 machine could launch a maximum of 14,040 jobs for processing within an 8 hour period.

The predicted number of jobs for one 8 hour period at JPL for Epoch k (3Q99) including an additional 200% increase in job activations due to reprocessing is 2,112 based on the February 1996 technical baseline.

Scheduling hardware

The scheduling function of the Data Processing Subsystem is done by a pair of Sun 20/712 workstations. Each workstation is attached to two 6.3 GB Sun SPARCstorage MultiPacks (external disk) via fast wide SCSI controllers. AutoSys software runs its Event Processor (using Sybase) on the primary workstation while the AutoSys Shadow Event Processor runs on the secondary workstation. When the Shadow Event Processor detects that the Event Processor has malfunctioned, the Shadow Event Processor takes charge of the execution of the schedule, thereby allowing the continued launching of production jobs. AutoSys will also be run in Dual Data Server Mode which allows AutoSys to replicate its database on separate disks. When a disk or database failure occurs on the primary database, AutoSys continues to operate, using the backup database.

The Sun operating system and applications will reside on disk internal to each of the 20/712 machines. The Sybase log, index, and data files will be on external disk. Two sets of three 2.1 GB external disks will be accessible via 2 fast wide SCSI controller cards for each machine.

Each 20/712 machine can be upgraded to use emerging hyperSPARC technology CPUs running at 150 MHz. Future experience with AutoSys and its Sybase database will determine if this extra capacity will be needed.

Each SPARCstorage MultiPack can be increased to a maximum of 12 disks for a total of 25.2 GB if required.

3.4.2.6.2 Configuration

- Production Planning/Management and PDPS DBMS Server: Quantity: 2
  - Sun SPARC 20/712
  - Clock: 75 MHz
  - CPUs: 2
  - Disk: 4.2 GB
  - RAM: 512 MB
  - Fast wide SCSI controller card: 2
  - SPECrate_int92 = 5,726, SPECrate_fp92 = 5,439
- Planning Disk: Sun SPARCstorage Multipack Quantity: 2
  - 6.3 GB (3, 2.1 GB disks)
  - Hot swappable drives with multiple active spindles
  - Maximum of 12 drives for 25.2 GB
- Queuing Server:Quantity: 2
  - Sun SPARC 20/712
  - Clock: 75 MHz
  - CPUs: 2
  - Disk: 4.2 GB
  - RAM: 512 MB
  - Fast wide SCSI controller card: 2
  - SPECrate_int92 = 5,726, SPECrate_fp92 = 5,439
- Queuing disk storage: Sun SPARCstorage Multipack Quantity: 2
  - 6.3 GB (3, 2.1 GB disks)

- Hot swappable drives with multiple active spindles
- Maximum of 12 drives for 25.2 GB

- Production Monitor: NCD HMX Pro Quantity: 4
  - X Terminal, color
  - RAM: 16 MB
  - Size: 21"

3.4.2.7 Data Processing Subsystem

The Data Processing Subsystem (DPS) includes three hardware CIs:

(1) *Science Processing (SPRHW)* -- The Science Processing HWCI (SPRHW) is the primary HWCI in the Data Processing Subsystem and contains processing resources (processors, memory, disk storage, and input/out subsystems) necessary to perform first time processing, reprocessing, and Algorithm Integration & Test (AI&T). SPRHW also provides the hardware resources necessary to support management of the science processing, in the form of a Queuing Server and Production Planner Stations. However, the queue management function in science processing is closely coupled to the ECS planning function, and the Queuing Server and Production Planner Stations are therefore discussed in the Planning Subsystem Design Specification, 305-CD-026-002. This chapter describes only the hardware resources required to execute the science software.

(2) *Quality Assessment and Monitoring (AQAHW)* -- The Algorithm Quality Assurance HWCI (AQAHW) provides hardware resources to support DAAC operations personnel in performing planned, routine, non-science QA of product data.

(3) *Algorithm Integration and Test (AI&T)* -- The Algorithm Integration & Test (AI&T) HWCI (AITHW) provides hardware resources to support the integration and test of science software at the DAAC, and system level validation, integration, and test. It is important to note that this HWCI provides workstations and tools for software integration and test, but does not provide the compute environment or compute capacity required for science software test. This integration and test compute capacity is included in the Science Processing HWCI.

The implementation of these HWCIs at JPL is described below.

3.4.2.7.1 SPRHW

The design specification for SPRHW is derived by first reviewing the requirements for SPRHW in Section 3.4.2.7.1.1. The requirements are traced from the first principles established in the system requirements, through the detailed processing requirements levied by the instrument teams, and through the models built to simulate system behavior under the load defined by the instrument teams. The technology assessments performed to support SPRHW specification are then reviewed in Section 3.4.2.7.1.2. The conclusions of the technology assessments are then applied to the derived, detailed system requirements to produce the SPRHW specification, provided in Section 3.4.2.7.1.3. Details of the specification are then discussed in Section 3.4.2.7.1.4 to show how they meet the system requirements.

3.4.2.7.1.1 SPRHW Requirements Analysis

The specification of SPRHW must satisfy sizing, expandability, reliability, maintainability, availability, compatibility, and interoperability requirements. These are discussed in the sections below.

SPRHW SIZING AND EXPANDABILITY. The SPRHW sizing and expandability requirements are derived from several sets of fundamental system requirements established in the ECS Functional and Performance Requirements Specification (F&PRS). Specific numerical detail is provided for these requirements by the processing plans provided by the instrument team inputs to the Ad Hoc Working Group on Production (AHWGP). Because the processing plans are quite complex, with many inter-relationships between products, significant analysis is required to understand the processing plans in order to reach a processing hardware design. This analysis has been performed using static and dynamic modeling. The modeling and design efforts have identified some design parameters that are not addressed by the AHWGP inputs; to address these design parameters, additional information concerning the processing plans has been solicited from the instrument teams in the form of a survey. The information derived at each of these steps has been used to determine the design parameters (requirements) for the science processing hardware. The following sections describe that process.

Functional And Performance Requirements. The F&PRS provides several requirements specifying the throughput and timeliness of ECS science processing.

Requirements EOSD1050, EOSD1060, EOSD1070, and EOSD1080 state the timeliness requirements for producing products for first time processing of data. Level 1, Level 2, and Level 3 products must be produced within 24 hours of the time that ECS receives all of the data required to produce the product. Level 4 products must be produced within seven days of the time that ECS receives all of the data required to produce the product.

Requirement EOSD1040 states that ECS shall have the capacity to perform reprocessing at twice the rate of first time processing. Requirement PGS-1300 states that ECS shall have the capacity to perform AI&T, production of prototype products, ad hoc processing for "dynamic browse" or new search and access techniques, and additional loads due to spacecraft overlap at one times the rate of first time processing.

Requirement PGS-1301 states the requirement that vendor peak processing estimates for processors be derated by a factor of four for design purposes.

Requirement PGS-1270 states the requirement that the processing design and implementation have expandability by a factor of up to three without design change, and by a factor of up to ten without major design change.

The Technical Baseline And The AHWGP Inputs. Appendix C of the F&PRS is included by reference in the F&PRS requirements. This appendix contains estimates of the volume of processing to be performed by ECS. Because these estimates have changed over time and become significantly more detailed as instrument team plans have matured, the material in Appendix C of the F&PRS has been replaced by a group of separately maintained documents referred to as the ECS Technical Baseline.

The Technical Baseline contains material that defines the level of processing required by each instrument for first time processing. Much of this data has been provided by the instrument teams in the form of inputs to the AHWGP. These inputs are updated approximately every six months;

the most recent updates to the AHWGP inputs and the ECS Technical Baseline were baselined in February 1996. The February 1996 Technical Baseline is therefore the basis for the CDR design for SPRHW.

AHWGP processing requirements are expressed in terms of Product Generation Executives (PGEs), which are the smallest scheduled increment of science processing. For each PGE, the AHWGP input identifies the DAAC at which the PGE will be executed, and provides the execution frequency, the list of input data requirements, the list of output data products, and an estimate of the number of millions of floating point instructions (MFPI) performed with each execution. For each input file, an estimate is given of the fraction of the file that is read by the PGE. The baseline also identifies the calendar quarters during which the PGE will be executed; this allows the instrument teams to identify how they will phase in their processing after the instruments are put on orbit. As a result, the processing demand for each instrument may vary by calendar quarter.

The Technical Baseline documents program plans and directives that affect the SPRHW specification. The hours of operation for each DAAC are provided. For DAACs having less than 24 hour per day, seven day per week operations, the assumption is made that all processing must be accomplished during DAAC operating hours.

The Technical Baseline also documents the program directive to phase the implementation of processing capacity for each instrument relative to the date of the instrument's launch. The purpose of the phasing factors is to provide sufficient early processing resources to support AI&T, without purchasing the required full-up capacity before it is needed. With **X** defined as the processing resources required to do first time processing for an instrument and **L** defined as the launch date of the instrument, the phasing factors are defined below:

- **0.3X for L-2 < t < L-1.** Pre-launch AI&T requires 0.3X during the period from one to two years before launch.
- **1.2X for L-1 < t < L+1.** Pre-launch AI&T and system I&T requires 1.2X during the year before launch. Standard instrument processing requirements (X) begin from the launch date and last for the remainder of the life of the instrument.
- **2.2X for L+1 < t < L+2.** Post-launch AI&T, standard processing, and reprocessing of data require 2.2X starting at launch plus one year.
- **4.2X for t > L+2.** Post-launch AI&T, standard processing, and reprocessing of data require 4.2X starting at launch plus two years.

The launch dates for instruments supported by ECS are documented in the Technical Baseline. Because the PGE processing plans are expressed on a quarterly basis, for the purpose of applying the phasing factors the launch dates are brought forward to the first day of the appropriate calendar quarter. The science processing requirements supported by Release B at JPL are for instruments launched on the ADEOS II (SWS) and ALT RADAR (DFA/MR) platforms. ADEOS II and ALT RADAR are scheduled for launch in 1Q99. However, for the purpose of synchronizing design and procurements for JPL with the rest of ECS, phasing for JPL will be assessed as if these instruments were launched on the AM-1 platform. AM-1 is scheduled for launch during the third quarter of (calendar year) 1998 (3Q98). Therefore the phasing factors for SPRHW are assessed at 3Q96, 3Q97, 3Q98, 3Q99, and 3Q00.

Specifications for SPRHW have been designed for each of the Release B dates identified above.

However, for the purpose of discussing the design, the 3Q99 period (also referred to within ECS as Epoch K) has been selected as a common frame of reference across the entire set of Release B Design Specifications. At Epoch K, AM-1 instruments are supported at the 2.2X level of processing.

Static Modeling. The AHWGP inputs define over two hundred PGEs, executed at five DAACS for eleven instrument teams. The PGEs create over three hundred products, and require over one hundred ancillary and Level 0 input data sets. The interdependencies of the products and PGEs creates a network so complex that it cannot be understood by hand. The inputs are therefore analyzed using models, to reduce the volume of data into aggregates for each instrument and DAAC, and to understand the dynamic behavior of the interdependencies. The first step in this analysis is to use a static model (spreadsheet) to analyze the PGEs.

The static model represents each PGE within ECS on a single line of a spreadsheet. The columns of the spreadsheet contain the attributes for the PGE: its process identifier, instrument, processing site, frequency of initiation, number of executions per initiation, total input file size, total output file size, number of input files, number of output files, volume of files staged per execution, volume of files destaged per execution, and number of MFPI per execution.

Most PGEs are executed once per set of inputs, and those inputs are produced (by the instrument and/or by other PGEs) periodically. However, some PGEs may be executed several times on a given set of inputs that are periodically produced. An example is a MODIS PGE that produces products defined in terms of geographic tiles; for each set of input data covering the whole earth, the PGE may be executed 355 times, once for each MODIS tile. Hence it is necessary to track both the frequency of initiation of the PGE (the periodicity of the inputs) and the number of times the PGE is executed for a given number of inputs.

The numbers and sizes of input and output files are evaluated by summing the inputs provided for the PGE by the instrument team. The staging and destaging inputs to the static model are derived from the AHWGP inputs. Staging refers to the process of moving data to the science processing resources, and destaging refers to moving data away from the science processing resources. SPRHW does not archive data; it retains over extended periods (more than 24 hours) only a very limited amount of ancillary data identified by the instrument teams as permanent. All other data required by or produced by processing must be staged or destaged to the ECS archive. The staging and destaging entries in the static model spreadsheet are calculated by subtracting the permanent ancillary file volumes from the total file volumes.

These inputs are then used to calculate average resource usage levels for processing, network input/output (I/O), archive I/O, and disk I/O. The processing usage is calculated as the number of millions of floating point operations per second (MF) required to meet the PGE's requirements based on the PGE's frequency of initiation, number of executions per initiation, and MFPIs per execution. Similarly, the data flow to the archive (due to destaging), from the archive (due to staging), over the network (due to staging and destaging), and over the disk I/O channels (due to processing, staging, and destaging) are calculated. These values are then aggregated (summed) for each instrument and DAAC.

One method of static model analysis is to calculate the average level of resource usage required to support each PGE, instrument, and DAAC, assuming that the processing is spread smoothly over time. This analysis ignores the timeliness requirements for products, but it produces a baseline estimate of the minimum resources required to keep up with the processing requirements. It is this analysis that defines the value of X used for phasing requirements.

Another approach for analysis is to manipulate the formulas used to calculate the derived values (the usage rates) to take into account the timeliness requirements; further, it is assumed that in the worst case each periodic product is executed at least once on the worst case day. This produces a (generally) worst case estimate of the resources required to meet the timeliness requirements for first time processing. (Because the static model cannot take into account the dynamic interactions between PGEs, it is theoretically possible that the worst case for the system is actually exceeded by this analysis, but the dynamic model has not shown this to be the case.)

Table 3.4.2.7.1-1, *JPL Static Modeling Summary Results*, shows static modeling results for JPL using February 1996 Technical Baseline inputs. The analysis depicted here shows average loading because all of the PGEs executed at JPL are planned on a daily basis (e.g., there are no weekly or monthly PGEs planned for JPL). These figures are also adjusted to take into account the eight hours per day, five days per week operations at JPL; this adjustment is done by taking a week's worth of processing requirements, and distributing them across a forty hour period. A processing capacity of 372 MF (derated) is required. Processing I/O to the disks during this period is estimated at 0.9 MB per second. Staging I/O from the archive is estimated at 0.8 MB per second, with 0.1 MB per second destaging.

Table 3.4.2.7.1-1. JPL Static Modeling Summary Results

Instrument	Processing (MF)	Processing I/O (MB/s)	Staging I/O (MB/s)	Destaging I/O (MB/s)
DFA/MR	178	0.3	0.3	<0.05
SWS	195	0.6	0.4	0.1
DAAC Total	373	0.9	0.7	0.1

Dynamic Modeling. The static model has significant limitations. It cannot take into account the dynamic interdependencies of the PGEs or the system's computing resources. As a result, it cannot accurately predict the end to end clock time required to produce a stream of products once Level 0 data has been received. It also provides extremely inflated estimates of the system staging requirements, because it must assume that every (non-permanent) file required for each execution of each PGE is staged for that execution; it cannot take into account that the file may already have been staged to SPRHW in support of some other PGE. On the other hand, it assumes uniform utilization of the SPRHW resources, not accounting for the fact that one type of resource (such as a processor) may be idle while the system uses another type of resource (a network).

To overcome these limitations, a dynamic model of a subset of ECS has been implemented. The dynamic model is implemented using the Block Oriented Network Simulation (BONeS) tool. BONes is a discrete-event simulation tool for analysis and design of communication networks and distributed processing systems. Components of a distributed processing system are represented by nodes, which have resources associated with them that get allocated as events request them. First time production of products by DPS is simulated by the Processing module, in conjunction with the Data Handler module, the Event Driven Scheduler, and the Ingest module. The Data Handler simulates the behavior of the ECS Data Server. The Data Handler stores and retrieves data from the permanent archive, routes data to the requesting subsystems, and manages tiered storage and staging resources. The Event Driven Scheduler monitors the availability of data, requests data to be staged from the Data Handler to Processing, routes newly created data to the appropriate Data Handler or Processing resource, and initiates execution of a process when all required inputs are present. It should be noted that the Event Driven Scheduler is not intended to serve as a simulator of the Planning Subsystem; rather, it simulates the effects of data arrival at ECS and the actions of the Planning Subsystem. The Ingest module simulates the Ingest subsystem, which accepts data from external systems and users and contains rolling storage of Level 0 instrument data.

The dynamic model is run by creating an input event stream representing the arrival times of Level 0 and ancillary data files. The PGEs are defined to the model in terms of their resource requirements and file dependencies. The system design is also represented as an input to the model, in terms of the number and capacity of system resources -- for example, the number of SPRHW processors and their throughput in MF. The Event Driven Scheduler then executes the event stream, which is driven by the external events (receipt of Level 0 and ancillary files) and by derived events (the availability of the data and computing resources required to execute a PGE). The simulation is run over an extended simulation period -- typically 21 days -- to examine the effects of products produced periodically. The simulation is started with an empty ECS system; there is therefore a starting transient in the simulation's output results. Because of this, the results of the first five days of the simulation are generally discarded.

The results of the dynamic model are analyzed to identify peak and average resource requirements, and average and maximum system response characteristics. Graphs showing resource utilization over time during the period of the simulation can also be generated.

The model explicitly represents each processor within SPRHW, and constrains the simultaneous execution of PGEs to the number of processors in the design, operating at the vendor's peak MF rating derated by a factor of four per the requirements. Average and peak processor utilization and average and peak processor queue lengths are reported, as well as processor utilization curves over the period of the simulation. These results identify whether processing backlogs are occurring, and whether there is excess processing capacity in the design.

For disk storage at the science processors, the model does not constrain the available space; instead, it implements an algorithm to depict the purging of unneeded data from the SPRHW storage array, and monitors the demand for storage. By plotting the storage demand over the period of the simulation, it can be determined when the peak occurs, and for what duration. This information is used to size the SPRHW storage arrays. The results of dynamic modeling runs for JPL indicate that only a modest amount of storage -- approximately 15 GB -- is required to support JPL processing. When one X reprocessing is added, this requirement increases only slightly to 16 GB.

Network and disk I/O are averaged over time to provide average utilization rates. The model represents these as constrained resources; hence, the model results provide assurance that a given level of network and disk I/O throughput will satisfy the system's requirements, and provide an approximation of the fraction of these resources that is used on average. At JPL, the dynamic results are consistent with the static results in indicating that traffic between the science processors and the Data Server will average about 1 MB per second.

<u>Memory Usage And I/O Survey</u>. The inputs to the AHWGP do not provide any information as to how the PGEs will use processing memory, or about the detailed characteristics of their disk I/O.

Although all of the potential platforms considered for SPRHW make use of virtual memory, the ratio of physical memory (RAM) to virtual memory required during the operation of a system is important for performance reasons. The rate at which memory is accessed by a PGE and the pattern of these accesses can also have important performance impacts. For the SPRHW specification, these requirements affect the amount of RAM, number of memory channels, amount of disk (for virtual memory), and number of disk channels (for virtual memory access). Because the SPRHW processing requirements are very demanding and generally require sophisticated and expensive processors, it is desirable to get as much throughput as possible from the processors by keeping as much of a PGE in RAM as practical.

Similarly, the size and pattern of disk I/O requests strongly affects the performance that can be expected from a disk I/O subsystem. Because of various overheads associated with each disk access, throughput from a disk subsystem increases strongly with the average size of the disk request, up to maximum limits imposed by the disk, interface, and controller technologies. While vendors usually quote I/O subsystem performance for large request sizes (hence peak performance values), it is important to know whether these request sizes are typical for ECS applications; and if not, to derate the vendor performance specifications accordingly.

The types of memory usage and file I/O characteristics that are needed to determine the system requirements for these resources can generally be determined either by code inspection or by measurement during execution. ECS solicited this information from the Release B instrument teams in January of 1996. Unfortunately, it is still too early for most teams to provide accurate assessments of their requirements, and little data has been received to date in response to the survey. In particular, the DFA/MR and SWS teams have not yet provided data concerning the memory usage and I/O characteristics of the PGEs to be executed at JPL. The integration and test of beta science software for Ir-1 during the first half of 1996 may provide requirements in time to support the procurement of the first increment of Release B hardware.

For purposes of the generation of the Release B CDR design, assumptions have been made in the absence of requirements data in these areas. It is assumed that each PGE will require approximately 128 megabytes (MB) of RAM. This figure is viewed as a reasonable upper limit for most algorithms, especially if the algorithms are designed with consideration of their memory requirements. It is recognized that some algorithms may require large data structures to iteratively refine their data using models, and will have correspondingly larger memory requirements. These uneven needs between algorithms are mitigated in part by the Symmetric Multiprocessor (SMP) architecture that has been selected for SPRHW.

It is also assumed that ECS SPRHW file I/O will be buffered by the platform operating system, with the average request size characterized by the operating system I/O buffer size. This assumption is made because it is believed that this correctly characterizes the use of HDF, which is expected to be the dominant form of disk access on the science processors. The buffer size varies by operating system, but is typically small (64 kilobytes or less) relative to request sizes used for direct file I/O (256 KB to 4 MB). This means that the vendor disk I/O performance ratings will be derated to reflect small request sizes.

SPRHW RELIABILITY, MAINTAINABILITY, AND AVAILABILITY REQUIREMENTS. The product generation function of DPS has an availability requirement of 0.96 (96%) and a mean down time requirement of not to exceed four hours. Implicit in these requirements is also the requirement that SPRHW be able to achieve it timeliness and throughput requirements while allowing for 4% non-availability and component outages of up to four hours.

SPRHW COMPATIBILITY AND INTEROPERABILITY REQUIREMENTS. The Release B ECS software must satisfy ECS requirements for the use of open systems technology, and must be compatible with other Release B subsystems. Specifically, the SPRHW hardware suite must be supported by OODCE. SPRHW must also support the network interfaces to be implemented by ECS. For the DAACs with smaller ECS requirements, including JPL, these interfaces are FDDI; for the DAACs with larger ECS requirements, these interfaces must support data exchange between DPS and DSS at aggregate rates (in Epoch O) of on the order of 150 MB per second.

3.4.2.7.1.2 Technology Assessments

The requirements identified in Section 3.4.2.7.1.1 can be compared to the capabilities of current and future technologies to identify candidate technical solutions. This type of evaluation can be done on paper, in the form of trade studies or technology evaluations, or it can be done in the laboratory, through prototyping and benchmarking. The paragraphs below discuss the technology assessment activities that have been performed to support the Release B design process, with emphasis on the activities performed since IDR-B.

TECHNOLOGY EVALUATIONS. A number of technology evaluations have been performed under ECS to identify the best technical approaches and products for the SPRHW suite. Three of these evaluations are discussed below.

Production Platform Families. The requirements for first time processing for instruments at the DAACs range from a few MF for the less compute intensive instruments, up to 4.5 GF for MODIS at GSFC. Computing requirements in the GF range have historically been the turf for vector supercomputers, but advances in massively parallel processors, symmetric multiprocessors, and workstation farms have pushed these technologies into this range of performance. An evaluation was performed for Release A and Release B of the following candidate platform family architectures for SPRHW:

A. Single processor workstations;

B. Farms of workstations connected via local area networks;

C. Symmetric Multiprocessors (SMPs);

D. Massively Parallel Processors (MPPS); and

E. Vector Supercomputers.

The key criteria used to evaluate the platform families were lifecycle cost per unit of processing power, expandability, ease of science software development, and flexibility. The evaluation found that the requirements for the less compute-intensive instruments could be met by single processor workstations, which are the least expensive and most flexible resources. For the compute-intensive instruments, however, only the SMPs, MPPs, and vector supercomputers offered the expandability required. Among these three, the vector supercomputers were found to have significant cost disadvantages. The SMPs were found to have significant advantages over the MPPs in the ease with which applications can be developed, and the evaluation concluded that the SMP platform class was best suited for ECS's high-end SPRHW requirements.

This evaluation is documented in *Platform Families for the ECS Project*, 440-TP-007-01.

Distributed And Parallel Processing. Parallel processing in both shared memory and distributed memory architectures is viewed as an emerging technique for solving large processing problems. An analysis has been performed to examine the benefits of distributed and parallel computing for ECS. The analysis studies various processing alternatives for ECS science algorithms and provides information on processing technologies. The analysis examines the applicability of using the OSF/Distributed Computing Environment (DCE), symmetric multiprocessing with shared memory, distributed multiprocessing (including workstation clusters), and massively parallel processing for ECS science software.

The SMP architecture is found to provide significant flexibility: it fully accommodates non-parallelized code, supports easy migration of non-parallel code to shared memory parallel processing, and can also support distributed memory parallel processing. This flexibility is viewed as giving SMP systems a significant advantage for ECS processing. Although a need to parallelize particular PGEs has not been identified to date, the ability in the future to parallelize ECS science software is an important consideration, especially with the large processing requirements of Release B and beyond.

This evaluation is documented in *Distributed and Parallel Processing For ECS Science Algorithms: A Trade Analysis*, 440-TP-008-01. ECS Science and Technology Lab prototyping efforts that have demonstrated parallel program development, based primarily on parallelization tools, are documented in 194-00569TPW and 194-430-TPW-001.

PROTOTYPES AND BENCHMARKS. Prototypes and benchmarks are used to assess the applicability of a technology or product to a set of requirements. Two sets of recently acquired benchmarks have been used in refining the ECS SPRHW design for Release B. The first set of benchmarks, measuring the performance of IP over HiPPI, was performed in the ECS development facility. The second set of benchmarks, measuring I/O subsystem performance on the SGI platforms, was performed at the University of Minnesota and by SGI.

Network Benchmarking. Benchmarking tests of the performance of IP over HiPPI have been performed in the ECS development facility. The purpose of these tests was to measure the throughput that can be achieved using IP over HiPPI, to determine whether IP introduces a significant overhead in HiPPI communications.

The tests used two SGI Challenge XL systems, equipped with SGI HIO HiPPI adapters. These systems were running version 5.3 of the Irix operating system. Two different benchmarking tools were used to send TCP streams from the memory of one system to the memory of the second system. Throughput rates were measured as the configuration parameters for TCP/IP were varied.

The maximum transfer rates observed in the test were approximately 55 MB per second, just over half of the 100 MB per second theoretically possible with HiPPI. SGI has stated that using version 6.2 of Irix, rates of up to 90 MB per second have been observed in their laboratories. This indicates that IP does not burden HiPPI with a substantial overhead, and that IP-based protocols can be used over HiPPI in ECS. This eliminates the need to develop custom protocols for ECS using raw HiPPI interfaces.

<u>I/O Subsystem Benchmarking</u>. The Laboratory for Computer Science and Engineering (LCSE) at the University of Minnesota, in affiliation with the Army High Performance Computing Research Center (AHPCRC), has performed a number of benchmarking tests on I/O subsystem performance on SGI platforms. These tests have included performing high speed data transfers over HiPPI using a lightweight TCP/IP protocol, and performing high data rate disk transfers. These tests have demonstrated that the SGI architecture can sustain I/O rates in excess of 150 MB per second between machines, and over 500 MB per second to locally attached file systems.

The HiPPI experiments performed at LCSE demonstrated the ability of the SGI platforms to support data visualization. In these experiments, a single Challenge server, configured with four HiPPI connections, was used to transfer data from its file system to the graphics processors of two SGI Onyx systems. A lightweight TCP/IP protocol referred to as "NFS-Bypass" was used to perform the transfer. This protocol, which provides an NFS-like interface, transfers data between systems using a socket to socket connection that bypasses most of the overhead normally imposed by NFS. Transfer rates for a single HiPPI connection, from disk to graphics processor, of 65 MB per second have been observed. Using multiple HiPPI connections transfer rates from a single machine of over 150 MB per second have been observed.

Research at LCSE has also been performed to evaluate the maximum transfer rates available from various storage configurations on SGI platforms. These experiments have focused on the use of striped, SCSI-2 based RAID file systems using SGI's XFS file system and direct I/O. The LCSE researchers have built file systems capable of sustaining over 500 MB per second transfer rates on a Challenge system. A key aspect of their findings in the building of fast file systems is the need to use large block request sizes. They found that block request sizes associated with buffered I/O -- I/O buffered by the operating system's I/O cache -- are 64 KB or less. Disk subsystem performance at these request sizes is substantially below peak levels; at this request size, throughput of less than 10 MB per second is observed on SCSI-2 channels having a theoretical bandwidth of about 20 MB per second. Using direct I/O, which is not buffered by the operating system's cache, and with request sizes of one MB or more, throughput rates rapidly approach the per channel limitation imposed by SCSI-2.

SGI has further tuned the NFS Bypass software to make efficient use of the Challenge memory subsystem, and is productizing the software. The product, Bulk Data Service (BDS), will be offered as an extension to Irix 6.2 in the second quarter of 1996. Significantly, since BDS is built on top of TCP/IP, it is not specific to HiPPI; BDS may be used to implement highspeed file transfers over any TCP/IP connection.

SGI has also recently performed benchmarking tests on their newest generation of RAID controllers. These tests indicate that sustained transfer rates of eight MB per second per controller are achieved when small request sizes (64 KB) are used. This benchmark is used as a basis for sizing the disk I/O subsystems for SPRHW in Release B.

3.4.2.7.1.3 SPRHW Specification

SPRHW has three top-level component types: Science Processors, Queuing Servers, and Production Planner Stations. As discussed earlier, the Queuing Server and Production Planner Station components are specified in the Planning Subsystem Design Specification.

Appendix A, Table A-1 provides detalied configuration information for the JPL SPRHW hardware suite for Release B, including Epochs c, g, k, and o. The intended function and the processing, memory, I/O subsystem, disk channel, storage device, network, enclosure, and console configuration are specified for each system in the SPRHW suite.

The Science Processors are characterized by their vendor, enclosure, processors, memory, I/O subsystems, internal disk drives, external disk systems, backup and update devices, network interfaces, and monitors. This section describes the selected hardware. The system designators defined in Table A-1 (e.g., SPRHW-JPL-1, or just -1) are used in the text below.

SPRHW VENDOR. The Release B SPRHW components will be provided by Silicon Graphics (SGI). The architecture trade-offs show that SMP systems provide clear advantages for ECS science processing, and SGI is a leading vendor of SMP systems. When considerations are taken into account for cost, availability of required ECS software capabilities (such as OODCE), availability of highspeed network components (particularly HiPPI), and ease of re-use of Release A hardware, the logical choice for Release B hardware is SGI.

Final vendor selection has not been made for the external disk systems required by SPRHW. A baseline design is presented here which features RAID-5 devices using SCSI-2 interfaces. This technology is mature and its performance is fairly well understood. However new technologies, particularly fibre channel based RAID arrays, are making their way into the market. If these products are found to be stable and cost effective before the first Release B procurement, they may be selected as the Release B baseline.

PROCESSORS. For new equipment purchased for Release B, SPRHW will use the MIPS R10000 processor. This chip has a superscalar 64 bit architecture, capable of performing two floating point operations per clock cycle. SGI has announced that the chip will be offered in a 275 MHz implementation in the second half of 1996. Using the derating factor defined in the F&PRS, this processor is estimated to provide 137.5 MF; the dynamic modeling runs made to support Release B CDR have been based on this processor.

The JPL processing requirements for Epochs C, G, K, and O have been analyzed. The 372 MF processing requirement, as presented above in the static modeling results, requires the equivalent of at least three R10000 processors for production processing. This requirement will be met by providing an SMP with four processors. (SGI SMP configurations are only available with even numbers of processors.) This machine, a Power Challenge L, will be denoted SPRHW-JPL-2 (or "-2" in the text that follows). Analysis of the reprocessing requirements at Epochs K and O shows that it will be necessary to upgrade this machine to six processors at epoch K and eight processors at epoch O.

The requirement for SSI&T processing power is 0.2X at Epochs C, G, and K, and 1.2X at Epoch O. The value of X for JPL, the average processing load during operational hours, is shown to be 372 MF by the static modeling. The AI&T requirement is therefore small until Epoch O, and can be satisfied by a single R10000 processor. This machine, an Indigo2 IMPACT 10000 workstation, will be denoted SPRHW-JPL-1 (or "--1" in the text that follows). Its excess processing capacity will be used to support the JPL Algorithm Quality Assurance requirements; see Section 3.4.2.7.3 below. In epoch O, the AI&T requirement (1.2X) is 446 MF. This requirement is satisfied with a four processor Power Challenge L, which replaces the Indigo2 workstation. (The Indigo2 workstation remains in the JPL complement in epoch O to satisfy JPL AQA requirements; it is re-designated AQAHW-JPL-1.)

MEMORY. In Section 3.4.2.7.1.1 above it was noted that data for memory requirements are not available yet for DFA/MR and SWS, and thus it would be assumed that each processor required approximately 128 MB of RAM.

For SMP configurations, the SGI memory architecture features leaf controllers, which process requests to a subset of the system memory. Each memory board can have one or two leaf controllers. For epochs C, G, and K, SPRHW-JPL-2 will be configured with 512 MB of RAM, configured on a single board with two leaf controllers. It will be upgraded to 1 GB of RAM, configured on two boards with four leaf controllers, for epoch O. The second JPL SMP, provided at epoch O, will be configured with 512 MB of RAM on one board, two way interleaved.

For the single processor workstation, SPRHW-JPL-2, a configuration with 128 MB of RAM has been specified.

I/O SUBSYSTEMS. The workstation science processors do not offer configurable I/O subsystems; I/O interface cards (device control cards and network interface cards) plug directly into the backplane. The number of backplane slots in these systems is sufficient to support the device and network cards required for the ECS configurations, and the I/O rates required for these systems are low.

For the SMP systems, the SGI architecture provides configurable I/O subsystems that attach to the backplane; each subsystem occupies one backplane slot and provides up to 320 MB per second of bandwidth. The subsystem card is referred to as a PowerChannel 2 or IO4 card. A system may have up to six IO4 cards, subject to backplane limitations.

The first IO4 card in an SMP system provides console and ethernet connections. Each IO4 provides serial and parallel connections, two fast wide differential (FWD) SCSI-2 channels, and space for two HIO controller cards. HIO controller card offerings include a HiPPI card, a FDDI card, and a card supporting three SCSI-2 channels.

The number of IO4 cards specified for each SMP is determined by allocating HIO slots to the FDDI and HiPPI interfaces (if required), and counting the number of SCSI-2 interfaces required. The number of SCSI-2 interfaces required is determined by the number of internal and external SCSI-2 devices supported by the system. In general, it is assumed that the internal slow SCSI-2 devices (CD-ROMs, floppy disk drives, and tape drives) will be aggregated on the first SCSI-2 channel. Internal disk drives will be allocated to the second SCSI-2 channel. External disk arrays will be allocated to subsequent SCSI-2 channels; the number of channels required is based on the desired throughput of the file system. For the JPL SMP configurations, the I/O subsystems are configured with a single IO4 card, which supports an FDDI HIO card and a SCSI-2 HIO card. One SCSI-2 channel is used for the CD-ROM and tape archive devices (see below), one for internal disks, and one for external disks. This leaves two unused SCSI-2 ports on this system.

INTERNAL DISK DRIVES. The bulk of storage for the science processors will be provided by external storage arrays. Internal disk drives will only be used to provide swap space for the operating system, and to provide file system space for the operating system and applications. Applications in this context is not intended to include the PGE executables or any temporary file space required by the PGEs; rather it refers to file system space requirements for the Autosys client software and ECS custom code. The file system requirement for the operating system and applications is not expected to exceed two GB.

The allocation for swap space is estimated at four times the size of the physical memory (RAM). This exceeds what is generally configured for servers, and probably represents an upper bound; if it is found that systems require virtual memory larger than four times their physical memory, it is likely that physical memory will also have to be upgraded to reduce paging.

SGI currently offers 2 GB and 4.3 GB internal disk drives and will soon offer 9 GB internal disk drives.

SPRHW-JPL-2 is configured with a single 4.3 GB internal disk drive for epochs C, G, and K; this is upgraded to two 4.3 GB drives at epoch O. The JPL workstation and the second JPL SMP (SPRHW-JPL-1) are configured with one 4.3 GB internal disk drive.

External Disk Arrays. The disk size and throughput requirements for SPRHW are determined on a DAAC by DAAC and host by host basis, using the static and dynamic modeling results. These requirements are translated into numbers of drives and controllers based upon the configurations available from the vendor. The current design baseline product for external disk arrays is the RAID-5 product from SGI.

The SGI RAID-5 arrays use one redundancy disk for each four data disks. Arrays are built in groups of five disks, with up to four groups (20 disks) in an enclosure. Up to four enclosures can be put in a rack.

An enclosure will support one or two controllers. Each controller can access one or more groups of disks in the enclosure. A group of disks within an enclosure can be accessed by both controllers; however, only one controller may access the group at a time. This form of dual attachment is useful only for implementing failover of the controllers (or hosts) without moving cables. Each controller within an enclosure can also be tied to more than one host; however, only one host may mount the associated file system at a time, and therefore this form of dual attachment is also only useful to implement failover. The controllers in an enclosure can be connected to different hosts, and in fact this configuration is specified for JPL.

The throughput to the SGI arrays is limited by the either the interface mechanism (at large request sizes) or by overheads in the host and the controller (at small request sizes). The SCSI-2 interface used in the SGI arrays allows a maximum bandwidth of 20 MB per second to a channel. At small request sizes, however, the overheads are expected to limit performance to not more than eight MB per second per controller. To avoid contention on the SCSI-2 channels that would significantly reduce throughput for large block requests, and would also modestly impact throughput for small block requests, each array controller is configured on its own SCSI-2 channel.

The number of SCSI-2 channels and array controllers is determined by dividing the throughput rate required for a system (determined from the static and dynamic modeling results) by the eight MB per second rate per channel assumed for small request sizes. This number is then rounded upward. (Although the disk I/O performed by a system will actually be a mixture of large and small block requests, no effort is made to determine an average throughput rate; rather, the slower rate associated with small block requests is used to represent the entire load. This increases the design margin for these components.) The number of enclosures and racks is then matched to this number of enclosures.

The external storage requirements at JPL can be met with a minimal configuration of disks and controllers. A single floor-standing enclosure will be used. Two of its four bays will be populated with sets of five 4.3 GB disks. The enclosure will be populated with two controllers; each controller will manage one set of five disks. These disks, managed in a RAID-5 configuration, will provide 17.2 GB of usable space per set.

The disk arrays will be configured with three power supplies (one redundant supply) and a minimum amount of write cache. (Vendor benchmarks suggest that write cache will not significantly improve performance for the request mix that SPRHW is expected to produce.)

BACKUP AND UPDATE DEVICES. Each science processor will be equipped with an internal CD-ROM, as this is the delivery mechanism employed by SGI for updates to operating system software.

Each SPRHW suite will include at least one machine equipped with a tape library. These tape libraries will provide backup capability for SPRHW and for other subsystems, using the FDDI backbone network. The tape library requirements for JPL will be satisfied by an Exabyte tape library, the EXB-210. The EXB-210 is an 8 mm Digital Audio Tape (DAT) library with eleven cartridge slots and two drives. The tape library will share a SCSI-2 channel with the CD-ROM on SPRHW-JPL-2.

MONITORS. In general, the science processors are to function as compute servers, and are not configured with sophisticated graphics processing capabilities. It is expected that the machines will be housed in raised floor environments where space is at a premium. The science processing hosts require a console to monitor the system at startup, and to perform some system administration tasks; however, this console need not be a bulky graphics monitor.

For the workstation, SPRHW-JPL-1, a sophisticated graphics capability is provided, and a full size graphics monitor is required. It is expected that this machine will be housed within the DAAC operations area, to support its AQA operations.

ENCLOSURES. The actual enclosures for the science processors and their disk arrays are generally of little interest, except that they impose constraints on expansion capabilities, and they occupy floor space at the DAACs.

The desktop workstation could be rack mounted, but because of its dual role for AQA this system is expected to be placed in the ECS DAAC operations area.

The Power Challenge L configuration uses a half height cabinet.

The enclosure for the external disk storage units is a floor-standing cabinet.

NETWORK INTERFACES. An FDDI subnetwork will be implemented at JPL to support the Planning and Data Processing Segment (PDPS). The design of this subnetwork is specified in the Design Specification Overview, 305-CD-020-002, and in Section 3.4.1 of this document. For the Power Challenge L, this interface is implemented with an HIO mezzanine card, occupying one slot on the PowerChannel 2 (IO4) board. For the Indigo2 workstation, the FDDI interface is implemented with a GIO card, which occupies a slot on the system motherboard.

3.4.2.7.1.4 SPRHW Design Discussion

This section provides a discussion of how the specification provided in Section 3.4.2.7.1.3 meets the requirements identified in Section 3.4.2.7.1.1. The sections below provide a discussion of how the specifications meet the sizing and expandability requirements, and what the general SPRHW failure recovery strategy will be.

SIZING AND EXPANDABILITY. It is important to note that although the science processors are divided into clusters of resources configured to deal with specific processing requirements, and are expected to be tuned and allocated for these purposes, this does not imply that the use of a processing cluster, or a processor within that cluster, is limited to one operating mode or instrument. The DAAC operations staff, using the planning tools provided by ECS, will determine how the DAAC work load is distributed across the pool of SPRHW resources at the DAAC.

Table 3.4.2.7.1-2, *JPL Processing Resources Comparison*, compares the resources required at JPL to those provided by the specification for each epoch of interest. The required values represent 1.2X, 2.2X, and 4.2X levels of processing calculated from the static model. The row titled "Configured" shows what the planned configuration provides. Each SCSI-2 disk channel is estimated to provide eight MB per second throughput. The FDDI network is estimated to provide eight MB per second throughput. Note that question marks are shown for the memory requirements, as these requirements are not accurately known at this time. Requirements for disk space, disk bandwidth, and network bandwidth for SSI&T are set to zero, as SSI&T requirements for resources other than processing are not easily predictable; however, the specification provides ample resources in these categories. The table shows that the specification meets or exceeds the peak and average requirements for each resource at each epoch.

Table 3.4.2.7.1-2. JPL Processing Resources Comparison

			C 3Q97	G 3Q98	K 3Q99	O 3Q00
CPU	Throughput	Required	446	446	818	1,562
	(MF)	*Configured*	*687*	*687*	*962*	*1,650*
RAM	Size	Required	?	?	?	?
	(MB)	*Configured*	*640*	*640*	*640*	*1,536*
	Interleaving	Required	?	?	?	?
	(N)	*Configured*	*3*	*3*	*3*	*6*
Disk	Space	Required	15	15	16	17
	(GB)	*Configured*	*34*	*34*	*34*	*34*
	Bandwidth	Required	0.9	0.9	1.8	2.7
	(MB/s)	*Configured*	*16.0*	*16.0*	*16.0*	*16.0*
Network	Bandwidth	Required	0.9	0.9	1.8	2.7
	(MB/s)	*Configured*	*8*	*8*	*8.0*	*8.0*

The ability to expand the SPRHW configurations merits a separate discussion. A DAAC's science processing capabilities can be expanded in two ways: by adding resources to existing hosts and disk arrays, and by adding new hosts and disk arrays. The former approach is referred to as upgrading in place.

The ability to upgrade in place is limited by the number of additional resources that can be added to a host. For the workstation science processors, this is pretty much limited to memory upgrades, graphics upgrades, and possible future processor upgrades. Memory configurations of up to 640 MB are available on these systems.

For the SMP hosts, the ability to upgrade in place is limited by the number of backplane slots that are unused in the base configurations, and by artificial limits that are built into the SGI product line.

The Power Challenge L has five backplane slots. Every system must have at least one processor board, one memory board, and one IO4 board. A system may therefore have up to twelve processors, configured as three boards of four processors each. The maximum memory configuration would feature three boards, or six GB of memory with six-way interleaving. If only one memory board and one processor board were used, three IO4 boards could be used. This would support six HIO cards, plus six SCSI-2 channels. This combination could be used to support a FDDI interface, a HiPPI interface, and enough SCSI-2 interfaces (a total of 18) to support a 144 MB per second file system. For a system with balanced processing, memory, and I/O, a practical maximum configuration would have two processor boards (eight processors), two memory boards (each with up to two GB of RAM and two leaf controllers), and one IO4 board (with FDDI and SCSI-2 HIO cards). This would provide 1100 MF, or 379 percent of the peak requirement at any Epoch, and would provide 512 MB per processor, or 400 percent of the current estimated memory requirement.

By filling the external disk enclosure with nine GB disks, the available space could be increased to 144 GB. However, to add more file system bandwidth would require additional enclosures, as the current implementation has its maximum of two controllers.

If growth beyond these scales is required, it will be necessary to add more hosts to the SPRHW configuration. The ability to add science processing capacity is essentially unlimited, but from a practical point of view, bottlenecks would arise in the FDDI network and at the archive, assuming that data traffic increased as the processing load increased.

FAILURE RECOVERY STRATEGY. The general strategy in the event of the failure of an SPRHW component is to re-distribute the first time processing load to SPRHW components having sufficient resources to handle the load. Reprocessing and AI&T, although important to ECS over the long haul, can be delayed or reduced until the failed components are replaced. Because SPRHW has redundant capacity to support AI&T and reprocessing, and because scheduling of SPRHW resources is performed dynamically by the queuing and planning resources, most failures will have little impact on the timeliness of production processing.

SPRHW Failure Recovery. The DPS reliability, maintainability, and availability (RMA) requirements of 96% availability and mean down time of less than four hours are met by the SPRHW design. An analysis demonstrating this is provided in *Availability Model/Predictions for the ECS Project*, 515-CD-001-004.

In the event of a failure in the SPRHW suite, the DAAC operators will isolate the fault and determine its severity. Vendor maintenance will be called and repair and/or replacement of the affected part will be initiated.

Depending on the severity and location of the failure, other management actions and decisions may be required. If the failed component only affects resources that were allocated to AI&T, there is no impact to DAAC production operations, and no further action to recover production activity is required.

If the failed component affects resources that were allocated to production, an assessment will be made whether any PGEs need to be re-started or re-run because of possible corruption. If this is the case, ECS production planning capabilities will be used to reschedule the PGEs. If the failed component has affected a limited subset of the production resources, the MSS subsystem will notify the Queuing Server that these resources are no longer available, and the Queuing server will appropriately stop scheduling these resources. If the remaining resources available for production processing are sufficient to keep up with the first time processing plan, an immediate re-plan may not be necessary; if the first time processing PGEs are prioritized above reprocessing PGEs (generally the case), the first time processing will remain on schedule. If it is necessary to shut down SPRHW resources in order to facilitate a repair, a re-plan can be generated, allocating time in the schedule for the repair.

If a failure reduces the working SPRHW resources allocated to production below the level required to support first time processing, the DAAC operators may choose to re-allocate AI&T resources to production. This may be done in one of two ways: by using the production and queuing software to logically re-allocate and re-plan the use of the system's resources, or by using the physical hardware in the AI&T hosts to replace failed hardware in the production hosts. The first approach, using the ECS system software to schedule production work on the AI&T platforms, is generally preferred, because it is not intrusive to the hardware. However, there may be circumstances when the second approach is simpler and faster. If the AI&T software environment is significantly different than the production environment (suppose AI&T was testing a new version of an operating system), and if the hardware failure in production is simple (a failed power supply), then changing hardware may be easier than changing software.

At JPL it is unlikely that components from the workstation (the likely AI&T platform) could be used to replace components in the SMP. If the SMP were to fail, production processing could be performed on the workstation. The workstation has sufficient processing power (137.5 MF) to handle the average first time processing load at JPL, if it is operated on a continuous (24 hour) basis; the JPL load averaged over five 24 hour days is 124 MF. The workstation has the same disk space, disk bandwidth, and network bandwidth as the SMP.

Data backup and recovery are a comparatively minor issue for SPRHW, because SPRHW does not provide long term, secure storage for data. Although SPRHW has large storage arrays, these arrays are used to hold ancillary data files and data granules for short periods of time. If a file system failure occurs within SPRHW, the algorithms, ancillary data files, and data granules can be recovered from the Data Server. Therefore the only data that would be backed up from SPRHW, and restored in the event of a failure, would be operating system and configuration files (i.e., the system disk). This backup capability is provided by the tape library configured on the SMP. In the event that recovery is needed, incremental and full backup tapes would be used to re-build the required file systems.

Network Failure Recovery. The FDDI subnetwork for PDPS provides a significant degree of fault tolerance in the physical communications system. Most media failures within the FDDI fabric will not result in any loss of service and no reconfiguration would be necessary in these cases (due to the basic nature of FDDI). Given the inherent fault tolerance of FDDI, it is not required to have multiple physical communications paths to each host. The JPL SMPs will use dual-attached station cards; the workstation will use a single-attached station card.

3.4.2.7.2 AQAHW

QA of ECS products will include non-science QA, in-line QA, and SCF-based QA. Non-science QA will generally entail data integrity checks on data products and metadata. In-line QA is a form of science QA in which the content of the QA is evaluated using science algorithms. Processing capacity for in-line QA, to the extent that it is specified in the AHWGP inputs and Technical Baseline, is included in the Science Processing HWCI (see Section 7, SPRHW). SCF-based QA is also a form of science QA, and is specified by the product development team. ECS provides support for SCF-based QA to the extent of providing archive and communications capacity for the SCFs to sample the products for QA purposes.

The types of non-science QA to be performed at the DAACs will be specified by the DAAC operations staff. These requirements are as yet largely unspecified. The sections below define the working assumptions being made as to AQAHW requirements, and the specifications that flow from those assumptions.

3.4.2.7.2.1 AQAHW Requirements Analysis

The requirements for AQAHW are based upon the need to have a DAAC-based quality assurance capability to ensure the integrity of the products produced by the DAAC.

DAAC-based non-science QA processing requirements are to be defined through interactions with the DAAC operations personnel. The current design assumption is that DAAC-based non-science QA processing will be performed at the DAACs in parallel with the other forms of QA (SCF-based QA and in-line QA). The design baseline thus includes a local (DAAC) QA workstation to support these DAAC data integrity checks. This local QA workstation is actually similar to a Science User workstation equipped with core Client Subsystem functionality. The QA workstation acts as a client to the Data Processing and Data Server Subsystems. The current operations concept assumes that the QA workstation hosts ECS as well as DAAC supplied processes (as deemed necessary by the DAAC operations personnel), which use a subset of the ECS services to "pull" production data sets using the subscription mechanism. The need for visualization support will be explored as product specific QA processes and requirements are worked jointly with the DAAC operations teams.

3.4.2.7.2.2 AQAHW Technology Assessment

The AQAHW requirements identified to date do not present any significant technical challenges, and therefore no special technology assessment efforts (prototyping, benchmarking, or product evaluations) have been performed to support the specification of AQAHW.

Because the PGE processing requirements at JPL are relatively small, the processing capacity provided by an SGI workstation can satisfy the AI&T processing requirements at this DAAC with capacity to spare. To take advantage of this spare capacity, the AI&T host has been configured with graphics options so that it can be used for QA visualization, if this is required by the DAACs. This dual use of hardware is achieved in the SGI product line by equipping the workstation with the R10000 chip used for production processing, and with graphics resources sufficient to meet data visualization requirements.

3.4.2.7.2.3 AQAHW Specification

The AQAHW hardware suite will consist of a graphics workstation (SPRHW-JPL-1) connected to ECS via the PDPS FDDI subnetwork. At JPL, this workstation will also function as an AI&T resource until epoch O, when it will become a dedicated AQAHW resource and will be re-designated AQAHW-JPL-1.

The AQAHW graphics workstation was selected to provide a software execution environment equivalent to the AI&T software execution environment in order to facilitate use of the AQA workstation for AI&T when necessary. The AQA workstation is also equipped with a graphics capability sufficient to support sophisticated visualization techniques.

The AQA workstation will be an SGI Indigo2 IMPACT 10000 workstation equipped with 128 MB of RAM. This workstation uses the R10000 chip, which is expected to be available in a 275 MHz implementation in the second half of 1996. The workstation will be equipped with an internal CD-ROM and a 4.3 GB internal disk drive. The workstation will provide a SCSI-2 connection for access to an external disk array. The external disk array will be a set of five 4.3 GB SGI disks controlled by an SGI RAID controller, and enclosed in a cabinet enclosure. This array will provide approximately 17.2 GB of usable space. The Indigo2 IMPACT 10000 enclosure is a desktop configuration. The workstation will be configured with a 19 inch color graphics monitor.

The AQAHW workstation will reside on the ECS PDPS FDDI network. This network will provide direct access between AQAHW components and the remainder of the PDPS suite. The AQAHW components may also communicate with other ECS components and the external world via the DAAC FDDI switch.

3.4.2.7.2.4 AQAHW Design Discussion

Because the requirements for non-science quality assurance at the DAACs are not well defined, a minimal complement of AQAHW has been specified for each DAAC. This complement could be expanded as necessary in a variety of ways.

If JPL expresses a need for additional workstations for QA personnel, but does not require visualization support for these staff, X-Terminals could be assigned to the AQAHW to provide these seats. These X-Terminals would be configured in the same way that the AI&T X-Terminals are configured (see Section 3.4.2.7.3.3), and would be attached to the ECS PDPS ethernet subnetwork.

If additional visualization seats were required, additional workstations (configured as above) could be added to the ECS PDPS ethernet subnetwork to support the requirement.

If additional memory is required in the AQA workstation, its memory can be expanded to a maximum of 640 MB.

The Indigo2 IMPACT 10000 workstation is offered with three graphics options; the entry-level option has been selected for use in the AQA configuration. If more sophisticated graphics are required, the graphics in the workstation can be upgraded, subject to the availability of a backplane slot.

3.4.2.7.3 AITHW

The Algorithm Integration & Test (AI&T) HWCI (AITHW) provides hardware resources to support the integration and test of science software at the DAAC, and system level validation, integration and test. It is important to note that this HWCI provides workstations and tools for software integration and test, but does not provide the compute environment or compute capacity required for science software test. This integration and test compute capacity is included in the Science Processing HWCI (SPRHW).

3.4.2.7.3.1 AITHW Requirements Analysis

The requirements for AITHW are based upon the need to have a software development, configuration management, and test environment at the DAAC to support the integration and test of science software delivered to the DAAC by the instrument teams.

The AI&T activity is expected to be characterized by intense activity at certain program milestones (the initial delivery of science software, for instance) and a much lower level of activity on an ongoing basis. There are no explicit ECS requirements identifying capacity, throughput, or response time requirements for AITHW; therefore, the sizing of the hardware has been based upon the size of the integration and test effort anticipated for each instrument and upon experience with the ECS Ir-1 release.

The number of AI&T seats provided at each DAAC has been specified by allocating two seats for each instrument supported at the DAAC. Four seats are provided at JPL for DFA/MR and SWS. The number of AI&T stations must be expandable to provide surge capacity during especially busy periods. The AI&T stations must provide the capability to support the AI&T tools, which provide graphical user interfaces. The AI&T stations do not have stringent reliability, maintainability, availability, and backup requirements, as they do not directly support production processing. The AI&T stations must be compatible with and interoperable with the target SPRHW hardware and the AI&T tools server.

The AI&T tools server must provide sufficient capacity to support the use of the development, configuration management, and test tools by the AI&T stations. Because the number of AI&T stations at JPL will be two, and the tools server is not also acting as the software build or test environment (which is provided by SPRHW), the AI&T server requirements are minimal. The AI&T tools server does not have stringent reliability, maintainability, availability, and backup requirements, as it does not directly support production processing. The AI&T tool server must be compatible with the AI&T stations and the target SPRHW hardware.

AITHW must provide a network printing capability to support the AI&T task.

3.4.2.7.3.2 AITHW Technology Assessment

The AI&T hardware requirements do not present any significant technical challenges, and therefore no special technology assessment efforts (prototyping, benchmarking, or product evaluations) have been performed to support the specification of AITHW.

Because the CPU resources required for AI&T will be provided by target machines in the SPRHW suite, or by the AI&T tools server, the AI&T station requirements can be met with X-Terminals. The use of X-Terminals for these stations has several advantages, including cost effectiveness, ease of maintenance, expandability, and compatibility.

3.4.2.7.3.3 AITHW Specification

The AI&T hardware suite at JPL will consist of four X-Terminals, one server, and one network printer. These components will be connected to ECS via the ECS local area networks at the DAAC.

AITHW COMPONENTS. The AITHW components will consist of workstations, a tools server, and a network printer.

AITHW Workstations. The requirements for AITHW workstations will be met at minimum cost by providing NCD HMX-PRO X-Terminals. These X-Terminals will be configured with 20 inch color monitors and 16 megabytes of memory to support the use of the tools specified for the AI&T tools server. Users will log on to either the AI&T tools server to use its software, or to a target machine in the SPRHW suite to build and test software in that environment.

The X-Terminals will be configured to allow the addition of memory if experience indicates this is necessary; experience with Ir-1 resulted in upgrades to the memory of X-Terminals purchased for Ir-1. Additional X-Terminals can be purchased and integrated quickly and easily if expansion of the AI&T seating capacity at JPL becomes a critical requirement. Other ECS operations workstations, such as those in the Algorithm Quality Assurance HWCI and the Planning Subsystem HWCI, can also be used to support short term increases in AI&T activity.

AITHW Server. The requirements for an AITHW tools server can be met by providing a minimal compute facility with local storage for AI&T data products and databases. A Sun Ultra 1 Model 140 has been selected for this function. Because the Sybase Relational Database Management System (RDBMS) will be used to support AI&T, the memory of the server will be upgraded to 128 MB, and two two gigabyte internal disks will be used to provide local storage. Backup and restore for the AI&T tools server will be provided over the network by the enterprise backup server within MSS. The AI&T tools server will be equipped with a CD-ROM for loading new operating system and commercial tools software.

AITHW Network Printer. The AITHW network printing requirement will be satisfied by providing an HP LaserJet 4M+ with 14 megabytes of RAM. This printer has 12 page per minute throughput.

AITHW INTERFACES. The AITHW server will reside on the ECS PDPS FDDI subnetwork. The AITHW workstations and printer will reside on the ECS PDPS ethernet subnetwork. These networks will provide direct access between AITHW components and the SPRHW suite. The AITHW components may also communicate with other ECS components and the external world via the DAAC FDDI and ethernet switches.

3.4.2.8 MSS and CSS Subsystems

The MSS and CSS Subsystem hardware have been sized and configured in a redundant configuration in order to provide for high availability of communications infrastructure and management services. The sizing rationale, therefore, applies to both MSS and CSS servers and will be presented in a single subsection.

The MSS Subsystem consists of a single hardware configuration item (MSS-MHWCI), which provides the servers, workstations, and printers needed for all local system management functions. The MSS-MHWCI provides processing and storage for the following MSS software components:

- Management Software Configuration Item (MCI) - provides system monitoring and control (via HP Openview), the database management system (Sybase), trouble ticketing (Remedy), fault and performance management (Tivoli), physical configuration management (Accugraph), security management, accountability management, billing and accounting system, mode management service, performance trending capability, report generation and distribution, and management data access (custom code / scripts used to import log file data to the relational data base management system)
- Management Logistic Configuration Item (MLCI) - Site and SMC maintenance and operations staffs will rely on configuration management to provide software change control (Clearcase), change request management (DDTS), baseline management (XRP), inventory/logistics/maintenance (ILM) management, training management, policy and procedure management, software distribution management (Tivoli), and software license management.
- Management Agent Configuration Item (MACI) - Agents are processes used to monitor and/or control managed objects distributed across heterogeneous platforms. Current COTS technology for network management uses network protocols such as simple network management protocol (SNMP to provide a way for the manager, the managed objects, and their agents to communicate. SNMP defines specific messages, referred to as commands, responses, and notifications.

The CSS Subsystem consists of a single hardware CI (CSS-DCHWCI), which provides the server for all CSS functionality. CSS contains a single CI, the Distributed Communications CI, which provides the following services:

- Common Facility Services - includes electronic mail, file access, bulletin board, virtual terminal, and event logger services
- Object Services - includes security, naming, message passing, event, thread, time and life cycle services
- Distributed Object Framework - includes OODCE framework functionality.

3.4.2.8.1 Rationale

The MSS/CSS processing complement for JPL was designed and sized for both the TRMM and AM-1 missions. The sizing of MSS/CSS subsystem hardware is based on the February 1996 version of the technical baseline. Storage requirements have been rounded upward.

***Processing Requirements*.** Processing requirements for the MSS and CSS subsystem are driven by the following types of transactions:

- HP Openview data collection from managed objects and ad hoc queries (server)
- Conversion / import of HP Openview and log file data to MSS Sybase DBMS (server)
- DBMS usage for report generation / ad hoc queries (server)
- Fault & performance management notification (server)
- Trouble ticketing (server)
- Order request tracking (server)
- Billing & accounting (workstation)
- Mode management (server)
- Usage for configuration, baseline, training, license, inventory, change request, software distribution inventory/logistics/maintenance and associated report generation (workstation)
- DCE logical server transactions (directory, security, time).

Server Sizing ECS already has experience with many of the COTS products to be loaded on the MSS server from previous work in Evaluation Packages (EPs) and EDF installations. Based on this experience, a profile of the MSS/CSS server that is operating under nominal load (e.g., HP Openview map is displayed, but no collections are in process) has been developed. To this, processing requirements have been added for specific types of transactions.

In the EDF, an HP 9000/735/125, rated at 160 MIPS, was loaded with HP Openview, DCE client, Sybase server, X-server, and operating system. Tests were run to examine the impact of various types of HP Openview functions on CPU utilization. HP Openview was configured to discover approximately 500 nodes within EDF and then displayed them as a node map. Minimal status polling was performed at 15 minute intervals. A variety of HP Openview on-line reports were generated to show such items as packet throughput and CPU utilization. During the testing, processes resident on the server were monitored. CPU utilization remained extremely low (i.e., less than 3%) except during operator queries and initialization. At system start-up, initialization of the various daemons used by HP Openview generated a load of approximately 50%. After start-up, functions that involved initialization of x-windows screens (e.g., generation of the node map or display of a performance graph) generated loads of 25-40% for a brief (less than 15 seconds) period of time. Multiple SNMP queries on a router increased CPU usage to approximately 20 percent, with the primary driver appearing to be the x-windows server. Simultaneous queries of two routers (to two different x-window screens) consumed a total of 50-60% of the CPU. Based on this benchmark, we assume that a basic configuration of a server, including HP Openview, Sybase, DCE client, and the operating system will require approximately 72 MIPS, and will provide adequate resources for routine HP Openview operations. To this must be added processing capacity to handle DCE server functions, HP Openview monitoring, processing of log files, Sybase report generation / ad hoc query capability, Remedy trouble ticketing, Tivoli monitoring, Tivoli software distribution management, mode management, order request tracking, and mail.

HP Openview and log file-to-Sybase data conversion are primary processing drivers that are expected to vary by DAAC. Table 3.4.2.8.1-1 shows estimated numbers of transactions for HP Openview data collection. HP Openview data collection is driven by the number of managed objects to be monitored and the number and frequency of management information base (MIB objects to be collected for each. Managed objects for each MIB type were counted based on the Release B hardware configuration for JPL. The number and frequency of data collection for each class of managed objects was provided by MSS developers as specified in the CSMS Database Design and Database Schema Specification, (311-CD-003-003, Appendix B). HP Openview provided an estimate of 100,000 instructions per transaction. Using this information, an average number of instructions per second required for HP Openview data collection was developed. These estimates appear to be reasonably in line with HP-provided performance information, which indicates that an HP 9000/735, a machine rated at 125 MIPS, is capable of performing approximately 1300 collections per second.

Table 3.4.2.8.1-1. JPL HP Openview Collection Processing Requirement

	# MIB Objects	Average Size (Bytes)	JPL Managed Objects	Collections per hour*	Collections per second	Estimated MIPS
Release B JPL (Hosts, RDBMS, Router, hubs)	1,953	4	122	90,908	25	2.5

* Note that the number of collections per hour was derived by multiplying each class of MIB objects (e.g., MIB II objects) by the number of managed objects within that class, and summing the results.

An estimate of 100,000 instructions per transaction was assumed for the conversion of each logged event to Sybase, based on the number of source lines of code for the MSS MDA component involved and an estimate of instructions needed to update the Sybase database. Instructions per transaction was multiplied by the number of logged events, including both HP Openview events and events collected from applications via the logging API. HP Openview events (transactions) are described in the previous paragraph. The number of application-generated entries was developed using the following assumptions:

- One log entry is generated for every system transaction, by every process that is included in the transaction thread.
- The number of “pull” transactions is based on the user model and reflects user service requests by DAAC. Pull transactions (e.g., directory, inventory search requests) are assumed to generate a conservative estimate of 10 log entries each from CIDM and data server processes.
- Order request tracking is dependent on the request for data by a user and the request for status of a data product by a user. For every user request for data, an EcRequest is stored in the management DBMS and updated as required by the DSS. The transaction frequency for EcRequest storage is related to the number of granules requested by user per DAAC. Updates made by the DSS to the EcRequest are considered to be a small percentage of the total granules requested. For every user request for status of a product, the appropriate EcRequest is retrieved from the management DBMS and made available to the client.
- The number of transactions on the “push” side includes external (DAAC-to-DAAC and L0) file transfers (4 log files each), processing-to-archive requests (4 log files each), and PGE execution (2 log files each). Push transactions were based on AHWGP data, which showed that JPL executes 176 PGEs per day and each PGE requires an average of 39 input/output file requests at Release B.

- In addition, major processes generate log entries of approximately 512 K (based on the MSS application MIB) once every 15 minutes. There are estimated to be 15 processes at each DAAC that will generate log entries every 15 minutes.
- Log files and HP Openview data will be kept for 14 days prior to archiving in long-term Data Server Storage.
- For Billing & Accounting, there are expected to be approximately 17,000 total daily user accounts. Each account will be logged and on demand available for information tracking. An approximate number of user accounts per DAAC was estimated from the February 1996 user pull technical baseline.
- To implement the mode management service, multiple modes are assigned to each logged activity and can be simultaneously executed. The overhead required to provide mode management capability is estimated at 30% of the total logged activity.

Log entry storage volumes are given in Table 3.4.2.8.1-2.

The MIPs required to import the total number of log files per day are given in Table 3.4.2.8.1-3.

Table 3.4.2.8.1-2. JPL Log Entry Storage Volume - Release B

Log File	Log Events per Transaction	Transaction Frequency per Hour	Total Logged Events per Hour	Bytes per Transaction	Total Size of Bytes/Hr	14-Day Storage Requirements (MB)
User requests	10	50	500	420	210,000	71
Request tracking	10	25	250	420	105,000	36
PGE execution	2	15	30	420	12,600	4
External file transfers	4	9	36	420	15,120	5
Processing-to-Archive Requests	4	585	2,340	420	982,800	331
Application MIB poll	15	7	105	512	53,760	18
Billing & accounting activity logging	2	170	340	420	142,800	48
Subtotal Rel B			3,601		1,522,080	512
Total Rel B (includes x30% for multiple modes)			4,681		1,978,704	665

Table 3.4.2.8.1-3. MDA Data Conversion to Sybase Processing Requirement

	Total HP Openview Events / Day	Total Log File Events / Day	MIPS for 8 hour Sybase import
Release B	2,181,792	112,344	8

At Release B, ad-hoc queries will be performed and statistical analysis collected from the Sybase database. Ad-hoc reports will be generated that include the following type of information; user accesses, trend analysis, fault occurrences, resource utilization, data production jobs and security events. Benchmarks are being run on a prototype Sybase database to evaluate performance. The prototype database was developed to do real-time benchmarking queries of designated working attributes that are expected to be of reporting interest (i.e. performance).

DCE has been installed in the EDF and used in the Engineering Packages (EPs). Running on an HP 715, rated at 77 MIPS, the DCE server functions used 8% of the CPU, or approximately 6 MIPS. An analysis was performed to determine how much additional load would be placed on the DCE server at Release B.

Load imposed on the DCE server is a function of the number of directory, security and time look-ups from client applications. A client application maintains its own cache containing the most recently accessed directory and security information, and will only access the server when a user is not found in its own cache. Many client applications will only access other clients in the DAAC, and so will never exceed their cache. CIDM and the Data Server APC, however, will be directly accessed by external user clients and so will need to access directory and security information for each user access. At JPL, the user model reflects a maximum of 50 users accessing per hour. Given that a directory and security lookup typically requires less than 0.5 seconds, it is unlikely that there will be more than 1-2 simultaneous hits on the DCE server. We estimate that 1 additional MIP processor capacity will be sufficient for the level of DCE accesses required.

In the EDF "Mini-DAAC" facility, Tivoli performance was evaluated on an HP 9000 J210/1 rated at 176 MIPS and with 256 MB of RAM. The Tivoli COTS package will be used primarily for performance management, fault management and software distribution (most likely through Tivoli Courier). Performance will be monitored, statistics collected, and faults detected via Tivoli GUI screens. Tests were run to determine Tivoli GUI screen CPU utilization. The benchmark was performed with one user and the following configuration; the Tivoli application, the platform operating system, xwindows, and the performance tool (glance plus). CPU utilization was minimal as expected with no applications running (.5% of the system CPU) and approximately 56 processes active.

Following initialization of the Tivoli application, CPU utilization remained low (<2%), with the Tivoli Management Enterprise (TME) desktop enabled and 61 processes active. CPU loading became more prevalent when an administration GUI was selected from the TME desktop. Peak utilization was recorded at 9% of the system CPU for a period of 10 seconds and 73 processes active. Max peak CPU utilization (approximately 11%) and IO throughput (13.5 MB/s) was recorded when enabling the policy region desktop. In steady state, CPU utilization measured approximately 3% of the system CPU. Opening multiple GUIs did not increase demands on CPU utilization (remained <11%) but linearly required more memory. The Tivoli vendor for this reason recommends 96 MB of RAM dedicated. Total CPU utilization allocation for Tivoli based on benchmark results is estimated at 11% of the system CPU or 20 MIPS. The targeted platform at each DAAC site will be upgraded from the platform used for benchmark calculations. Recognizing the emphasis by Tivoli for memory and moderate processing needs, additional processing and memory capabilities were added to the MSS management server in Release B to provide adequate resources in support of the Tivoli product.

Remedy was evaluated on the HP 9000/735/125 for CPU utilization. The application required very little CPU allocation (<1%). A more significant load was present when performing browse or ticket assignment functions (approximately 6%). Submittal and processing of a trouble ticket required less than 1% of the CPU capacity.

The server requirements, as dictated by the rationale given above, is synopsized in Table 3.4.2.8.1-4.

Table 3.4.2.8.1-4. CSS/MSS Server Configuration - Requirements Estimate

Server Load Sources	Estimated R-B MIPS
Basic configuration (includes HP Openview and DCE client)*	72
Additional HP Openview data collection*	3
Sybase Server and Client*	50
Tivoli *	20
Remedy	11
MDA (log conversion to Sybase)	8
MSS Agent*	3
DCE server (including additional processing for peak directory and security transactions)*	7
Word Processor	1
Spreadsheet	1
Other Common Services (Mail, file transfer, etc.)*	5
Total * These items were considered to be potentially active at the same time. MDA database update is assumed to be run in off-peak hours, and not concurrently with Sybase report generation functions.)	171

Workstation Sizing There will be two MSS workstations at each DAAC site. Workstation # 1 will primarily contain the MLCI software. This includes software change management (clearcase), change request management (DDTS), baseline control management (XRP), software license manager and inventory/logistics/maintenance (ILM) management. Policy & procedures management and training management will be configured on workstation # 2. Each MSS Workstation will contain the Sybase client, DCE client, Tivoli client, MSS agent, and operator tools.

The DDTS tool was evaluated for performance in the EDF facility on a Sun SPARC 20/50 rated at approximately 130 MIPS and 64 MB of RAM (DAAC targeted platform will be an upgrade version). DDTS is the change request manager and maintains and tracks potential changes (via configuration change requests) to the ECS System. Configuration change requests (CCRs) will be created, logged into the DDTS database and tracked by a CM specialist. Tests were performed to determine CPU utilization for implementation of these tasks. The benchmark was performed with one user, the DDTS application configured with the platform operating system, xwindows and the performance tool (proctool). Following initialization of the DDTS application, CPU utilization as expected was very low, <1%. For each instance that a CCR was either submitted, modified or logged, the CPU utilization remained below 3% and memory utilization less than 8%. Table 3.4.2.1-5 shows that processing utilizations increased significantly when queries were made to the DDTS database.

Table 3.4.2.8.1-5. DDTS Benchmark Results

Benchmark Test	# Records	CPU Utilization (% of system CPU)	Memory Utilization (% of system memory)	IO Throughput (KB/s)
CCR submittal/creation	-	1.4 %	6.6 %	4
CCR registration	-	2.3 %	7.1 %	4
EP4 database query	128	9.7 %	7.2 %	11.3
EP6 database query	279	13.5 %	7.3 %	11.7
EP4 + EP6 database query	407	16.5 %	7.5 %	11.8
DDTS (inclusive) database query	1232	30.8 %	7.5 %	12.2

CPU utilizations ranged from 10% of the system CPU to approximately 30%. The number of records in the development environment is expected to be substantially higher than at the DAAC sites. For this reason, a conservative estimate of a maximum of 400 records is used to result in a CPU utilization allocation of approximately 21 MIPS. Memory utilization and IO throughput were moderate and appeared constant for each test performed.

Processing requirements for baseline management COTS (XRP), was estimated from vendor specifications. For a 30 user system, the XRP vendor specifies a processing requirement of 100 MIPS. Each DAAC site is assigned to have 2 XRP users and therefore will require approximately 7 MIPS.

Vendor specifications suggest an allocation of 35 MIPS for the Clearcase Virgin Object Base (VOB) Server. The VOB server is the most compute intensive of the Clearcase server applications due to its required database processing. In the EDF, Clearcase was installed on a SPARCstation 10, equipped with 120 MB RAM, rated at 109 MIPS, and with an ethernet interface. The SPARCstation 10 was initially used for Tool kit development, as well as CM of the Evaluation Prototypes. With moderate numbers of users, the SPARCstation 10 provided good performance. At peak use (15-20 simultaneous users viewing items, manipulating the contents of the database, and executing directly out of Clearcase), performance was adversely affected. Usage at the DAAC is not anticipated to require more than 5 simultaneous users, frequency of use is anticipated to be much lower, and applications will not be executed from the Clearcase tool. Additional benchmarks will be run as ECS code and science algorithms become available to help determine the precise Clearcase processing requirements at the DAAC. EDF experience suggests that a workstation configuration in the SPARCstation 20 range should be adequate to support Clearcase, other MLCI COTS, DCE and billing & accounting and Tivoli clients.

On MSS Workstation #2, the COTS products expected to exert the larger processing loads are billing and accounting (B&A) and performance trending. Other primary load contributions come from training management, policy and procedures, and the DBMS report generator.

Major B&A processing loads will occur during nightly batch imports to the Sybase server which is not resident to MSS Workstation #2. Processing of B&A transactions such as accounts received, purchase orders placed and products delivered are expected to exert a moderate load on the MSS Workstation due to the expected number of user requests for data as provided by user modeling.

Selection for the performance trending statistical analysis package is in progress. Statistical and historical performance data will be analyzed to assure optimum usage of system resources. A determined number of performance attributes will be analyzed by the statistical tool. Performance trending and other resident COTS packages such as training manager, policy and procedure manager and DBMS report generator are expected to require a small to moderate load on the MSS Workstation.

Tables 3.4.2.8.1-6 and 3.4.2.8.1-7 show configuration requirements for the MSS workstations. They reflect a best estimate of load to be imposed on each MSS workstation. It assumes that most functions run concurrently. Operator functions can be spread across workstations in such a way as to balance processing loads.

Table 3.4.2.8.1-6. MSS Workstation #1 Configuration - Requirements

Workstation Load Sources	Estimated MIPS
Basic configuration (includes Clearcase and Operating System)*	50
Software License Management*	5
DDTS*	21
XRP*	7
Tivoli Client*	5
Sybase Client*	10
Word Processor	1
Spreadsheet	2
Graphics	1
Inventory/Logistics/Maintenance Management	15
MSS Agent*	2
DCE Client*	5
B&A Client*	5
Other Common Services (Mail, file transfer, etc.)	5
Total * These items are considered to be potentially active at the same time	125

Table 3.4.2.8.1-7. MSS Workstation #2 Configuration - Requirements

Workstation Load Sources	Estimated MIPS
Basic configuration (includes Billing & Accounting and Operating System)*	35
Training Management*	5
Performance Trending*	15
DBMS Report Generation*	10
Policy & Procedures*	5
Tivoli Client*	5
Sybase Client*	10
Clearcase Client*	10
Word Processor	1
Spreadsheet	2
Graphics	1
MSS Agent*	2
DCE Client*	5
Other Common Services (Mail, file transfer, etc.)	5
Total * These items are considered to be potentially active at the same time	102

Storage Requirements Major datastores for the MSS and CSS subsystems include: HP Openview files, application log files (including request order tracking, billing & accounting and mode management), the Management DBMS, and Clearcase-managed data for software change management.

Other datastores include DCE directory, security data, mail, trouble ticketing, Tivoli, DDTS, baseline control management data (XRP), ILM, billing & accounting client, training management, policy & procedures, and DBMS report generation.

The size of the data storage for HP Openview has been estimated from the determination of the frequency of transmission of the necessary information of all the appropriate attributes of the managed objects during one hour period. It was assumed that fourteen days worth of HP Openview data are stored.

A description of how application log file volume was estimated is in the previous section (Processing Requirements). Log file volume is provided in Table 3.4.2.8.1-2 based on an assumption of fourteen days storage prior to archiving in the data server archive.

The storage requirement for the Management DBMS was based on a worst case assumption that all the records from both the log files and HP Openview are stored in the Management DBMS, with an additional 10% for table overhead and summarization records. It is assumed that one months worth of data are maintained in the Management DBMS at a time.

Storage requirements for Clearcase are based on the assumption that Clearcase will store two copies of all source code (including ECS application source and algorithms) and two copies of all executables. This will enable recovery of the previous version of any application if required. In addition, Clearcase will store test data and configuration files.

Tivoli sizing estimates are based on the number of performance attributes that will be monitored as specified by MSS developers in the Release B CSMS System Management Subsystem Design Specification, (305-CD-029-001, Section 6.6). These include system, application, process, and disk performance metrics. The monitoring frequency is dependent on the performance attribute. A worst case polling frequency of once per minute for all attributes was used in sizing calculations. The size of a typical fault/performance notification was estimated at 256 bytes.

Approximately 400 trouble tickets per day are estimated to be assigned, or approximately 17 per hour. The size of a trouble ticket is approximately 256 characters. Trouble ticket frequency and size are worst case.

To determine DDTS sizing requirements, the frequency non-conformance reports (NCRs) are generated on a daily basis was identified with the report size. A NCR was evaluated due to its similarity to a configuration change request (CCR). The number of CCRs generated at the DAAC sites are not considered to be more then necessary in a developmental environment.

There are expected to be approximately 16 periodic reports that will be produced on a daily, weekly, monthly and annual basis. Reporting areas include data production, fault identification, user accesses, resource utilization, user services activity and trouble ticketing. The size of an average report is estimated to be 15 KB. The aggregate number of reports generated is approximately 1 per hour.

The cumulative datastores of XRP, ILM, billing & accounting client, training management, and policy & procedures was estimated based on vendor provided information and experience in the development facility.

Disk space requirements of the MSS management server COTS applications are listed in Table 3.4.2.8.1-8. These applications will be stored in RAID and available for download to local disk. The RAID device interface is Fast/Wide SCSI which offers application access times comparable with local disk.

Table 3.4.2.8.1-8. COTS Product Disk Requirements

COTS Product	Disk Requirement (MB)
HPOV	2,000
Tivoli	100
Trouble Ticket (Remedy)	50
Sybase Server	1,000
Clearcase	2,000
DCE Server	200
Accugraph	50
TOTAL	5.400

The storage requirement for the Sybase DBMS is estimated to be 2 GB, Clearcase 3.9 GB, Tivoli 114 MB, Remedy 2 MB, DDTS 7 MB, DBMS Report Generator 5 MB, and 145 MB for all other datastores combined. Storage requirements for DCE directory and security stores are based on the number of predicted users as provided by user modeling. The total storage requirement for CSS is estimated to be 496 MB for Release B as specified in Table 3.4.2.8.1-9.

Additional RAID storage is allocated for safeguard of HP Openview functions and storage of billing and accounting transaction logs. Other real time functions (i.e. Tivoli and Remedy) will be replicated to the CSS server. A copy of all management data will be stored in RAID on a daily basis and safestored into a DLT tape drive via the management backup server. As required, the management data will then be stored into ECS data server archive.

The total storage requirement for Release B is estimated to be between 15 and 17 GB as specified in Table 3.4.2.8.1-10 (includes additional storage for Sybase swap space).

Table 3.4.2.8.1-9. **JPL** *CSS Release B Storage Requirement*

CSS Data Store	# of Users	Size of Record (# Bytes)	14-Day Storage Requirements (MB)
DCE Directory	17,000	1,000	238
DCE Security	17,000	1,000	238
Mail	348	4,000	20
Total Storage Requirement			496

Table 3.4.2.8.1-10. JPL MSS Release B Storage Requirements

Datastore	Freq. of Events/Hr	Size in Bytes/ Transaction	Size in Bytes Transmitted/Hr	14-Day Storage Requirements (MB)
HP Openview Datastore	90,908	5	454,540	153
Application log files	4,681	420*	1,966,020	661
Sybase DBMS				1,679
Clearcase				3,942
Tivoli	1320	256	337,920	114
Remedy	17	256	4,352	2
DDTS	8	2400	19,200	7
DBMS Report Generator	1	15,000	15,000	5
Other Datastores (ILM, XRP, B&A client, training, policy & procedures)				145
Application Disk Space Requirements				6,678
Total Storage Requirement				13,335

* Application polling generates 512 byte logs. These have been included in the per hour total.

Processor Selection Choice of the MSS/CSS Server platform was based on Release B processing requirements, COTS to be hosted on the platform, and price/performance data provided by EDS. Based on the Release B processing requirements, a medium-range server class platform was chosen. HP is the preferred vendor, since HP Openview and OODCE will be principal COTS products on these platforms, and HP is one of the principal developers of DCE and OODCE.

3.4.2.8.2 Configuration

The following configuration will be provided for the JPL LSM for Release B, which includes the MSS MHWCI and the CSS DCHWCI.

- MSS Local Management Server and CSS Communications Server: 2 HP 9000 J210/2 processors, 384 MB of RAM and 4 GB of storage.
- RAID Storage: 28 GB total storage
- Workstations:
  - 1 Sun SPARC 20/50 with 128 MB of RAM and 8 GB of storage (This workstation will house configuration management software)

- 1 Sun SPARC 20/50, 128 MB of RAM and 4 GB of storage

• Management Data Backup Server
  - 1 Sun Ultra 4-slot with 128 MB of RAM and 4 GB of storage

• Printer
  - 1 HP Laser Jet 4M+ Printer, 12 ppm/14 MB

The JPL DAAC will contain two primary servers for its LSM configuration, cross-strapped to RAID disk to enable warm backup. MSS and CSS applications will run on separate systems but in case of contingency, either system will be capable of running both subsystems.

The HP 9000 J210 is a high performance processor specifically designed for compute intensive and graphic applications. It includes a 176 MIPS processor which supports our requirements of less than 164 MIPs for Release B as shown in Table 3.4.2.8.1-4.

The configuration at JPL will include two Sun Sparc 20/50 workstations. One of the workstations which will house configuration management software will be configured with higher memory and higher storage (128 MB of RAM and 8 GB of hard drive).

The DAAC configuration for JPL includes a Digital Linear Tape (DLT) Library which implements helical scan technology which averages 20GB storage capacity per cartridge with a data transfer rate of about 3 MB/second.

3.5 Software/Hardware Mapping

With the exception of the Client subsystem, each subsystem has been designed to incorporate hardware CIs that include the components (processors, servers, archive robotics, etc) on which the software components run. Table 3.5-1 provides a mapping of PO.DAAC ECS Release B software components to the applicable hardware components.

Table 3.5-1. JPL Hardware to Software Component Mapping (1 of 8)

HWCI / units	Subsystem	CSCI	CSC
SPRHW/science processors	Data Processing	AITTL	Binary File Comparison Utility Code Analysis Tools HDF File Comparison Utility Profiling Tools Standards Checkers
		PRONG	Data Pre-Processing PGE Execution Management Resource Management
		SDPTK	All CSCs
	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Management	MACI	All CSCs

Table 3.5-1. JPL Hardware to Software Component Mapping (2 of 8)

HWCI / units	Subsystem	CSCI	CSC
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
SPRHW/queuing management server	Data Processing	PRONG	PGE Execution Management Resource Management Product
	Planning	PLANG	All CSCs
	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
AITHW/AI&T DBMS server	Data Processing	AITTL	Binary File Comparison Utility Code Analysis Tools Data Visualization Tools Documentation Viewing Tools ECS HDF Visualization Tools HDF File Comparison Utility Profiling Tools Report Generation Tools Standards Checkers
		PRONG	COTS COTS Management Data Management
		SDPTK	All CSCs
	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
AITHW/AI&T Operations workstations	Client	DESKT	All CSCs
		WKBCH	All CSCs, except - User Registration Tools

Table 3.5-1. JPL Hardware to Software Component Mapping (3 of 8)

HWCI / units	Subsystem	CSCI	CSC
	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Data Processing	AITTL	Data Visualization Tools Documentation Viewing Tools ECS HDF Visualization Tools PGE Processing GUI PGE Registration GUI Product Metadata Display Tool SDP Toolkit-related Tools SSAP Processing GUI Update Data Server GUI
		PRONG	COTS COTS Management Data Management
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
AQAHW/QA workstations	Client	DESKT	All CSCs
		WKBCH	All CSCs, except - User Registration Tools
	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Data Processing	PRONG	Quality Assurance Monitor Interface
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
PLNHW/PDPS DBMS server	Planning	PLANG	All CSCs
	Data Processing	PRONG	PGE Execution Management Resource Management
	Client	DESKT	All CSCs
		WKBCH	All CSCs, except - User Registration Tools (

Table 3.5-1. JPL Hardware to Software Component Mapping (4 of 8)

HWCI / units	Subsystem	CSCI	CSC
	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
ICLHW/ingest server	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Ingest	INGST	All CSCs
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
	Client	DESKT	All CSCs
		WKBCH	All CSCs, except - User Preference Tools
ACMHW/administration and operations workstations	Client	DESKT	All CSCs
		WKBCH	All CSCs, except - User Preference Tools
	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy

Table 3.5-1. JPL Hardware to Software Component Mapping (5 of 8)

HWCI / units	Subsystem	CSCI	CSC
ACMHW/APC servers	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Data Server	SDSRV	All CSCs
		STMGT	Service Clients File Peripherals Resource Management
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
DIPHW/distribution servers	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Data Server	DDIST	All CSCs
		STMGT	Service Clients Peripherals Resource Management
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
DRPHW/FSMS servers	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Data Server	STMGT	All CSCs
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy

Table 3.5-1. JPL Hardware to Software Component Mapping (6 of 8)

HWCI / units	Subsystem	CSCI	CSC
DRPHW/DBMS servers	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
	Data Server	SDSRV	DB Wrappers (Illustra DBMS)
DRPHW/document server	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Data Server	DDSRV	All CSCs
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
DMGHW/data specialist workstations	Client	DESKT	All CSCs
		WKBCH	All CSCs
	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
DMGHW/administration and operations workstations	Client	DESKT	All CSCs
		WKBCH	All CSCs

Table 3.5-1. JPL Hardware to Software Component Mapping (7 of 8)

HWCI / units	Subsystem	CSCI	CSC
	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
DMGHW/DBMS servers	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	Data Manage-ment	DDICT	All CSCs
		DIMGR	All CSCs
		GTWAY	All CSCs
		LIMGR	All CSCs
	Interoperability	ADSRV	All CSCs
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
MSS/MSS workstations	Client	DESKT	All CSCs
		WKBCH	All CSCs
	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
	ISS	INCI	All CSCs
	Management	MACI	All CSCs
		MCI	All CSCs
		MLCI	All CSCs
		MHCI	All CSCs
MSS/MSS LSM Server	ISS	INCI	All CSCs
	Management	MACI	All CSCs
		MCI	All CSCs
		MLCI	All CSCs
		MHCI	All CSCs

Table 3.5-1. JPL Hardware to Software Component Mapping (8 of 8)

HWCI / units	Subsystem	CSCI	CSC
	Communication	DCCI	Electronic Mail Services Event Logger Services File Access Services Life Cycle Services Message Passing Services Thread Services Time Services
CSS/CSS server	Communication	DCCI	All CSCs
	Management	MACI	All CSCs
		MCI	Automatic Actions Fault Management Management Proxy Performance Management Performance Management Proxy
User workstation	Client	WKBCH	All CSCs
		DESKT	All CSCs
	Ingest	INGST	User Network Ingest Interface

Note: "All CSCs" refers to those CSCs for a specific CSCI that is identified in the Component Analysis Table in Section 3.3.2 of this document.

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